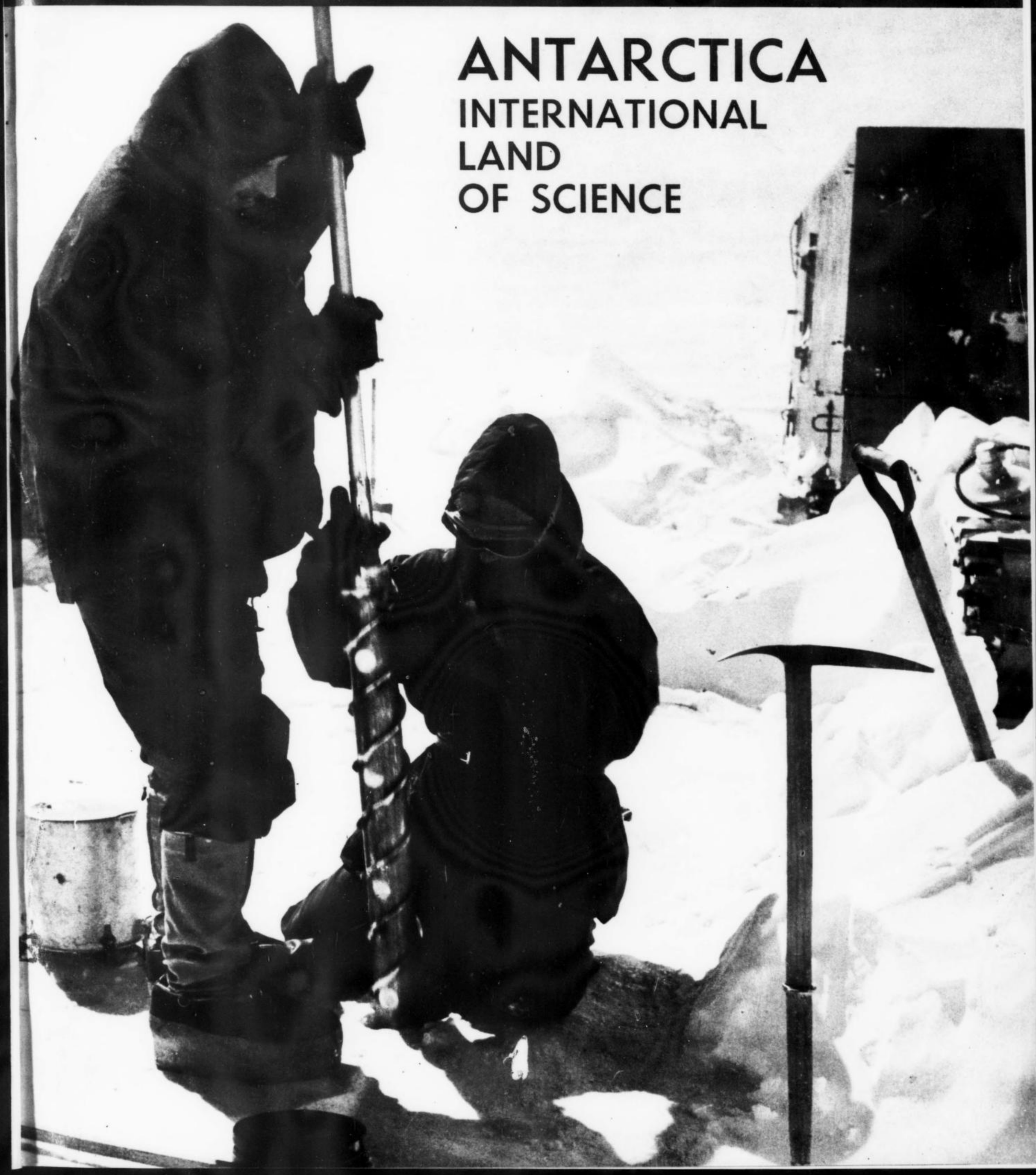
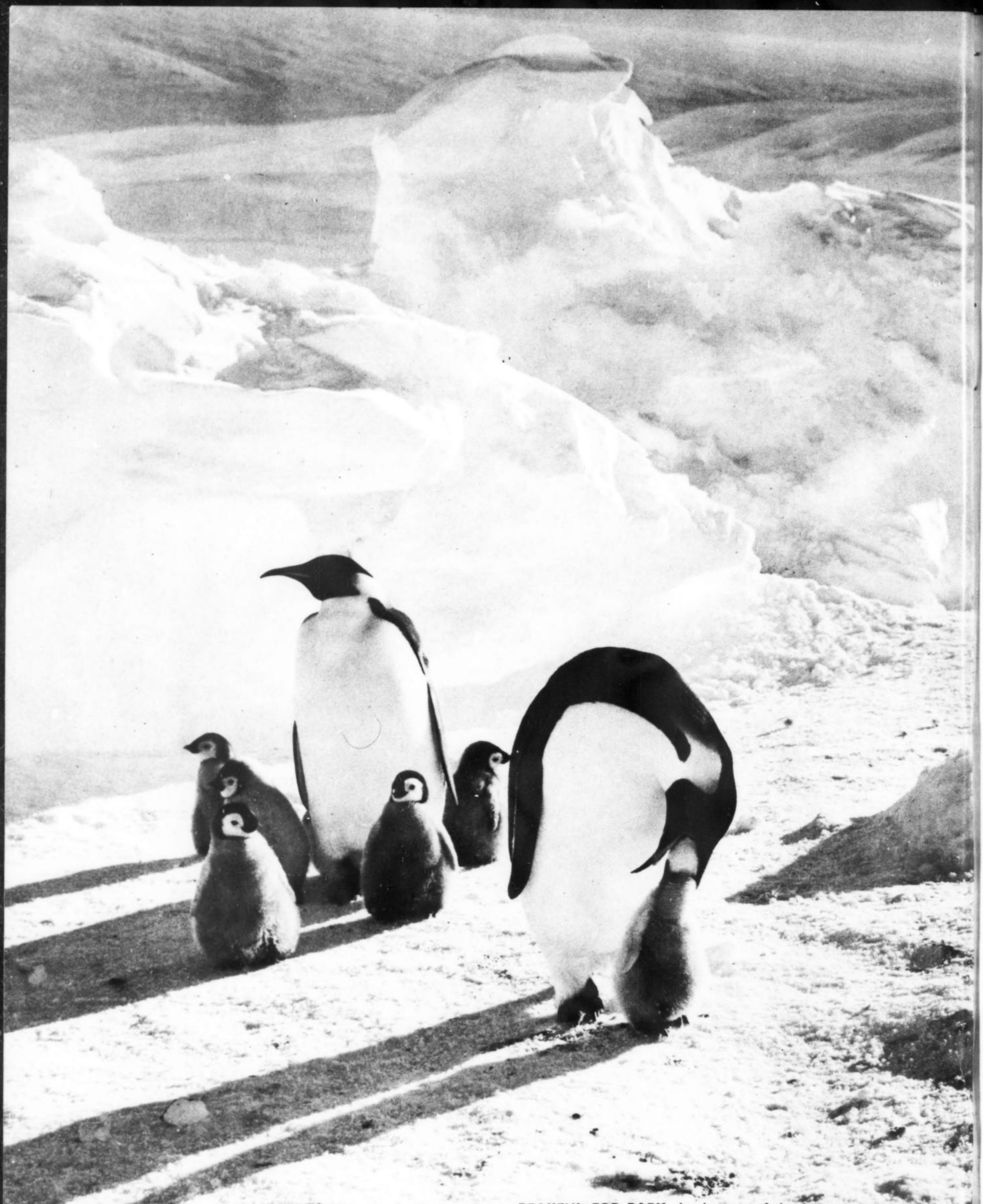
A WINDOW OPEN ON THE WORLD

The UNESCO Courier

JANUARY 1962 (15TH YEAR) - PRICE : 50 CENTS (U.S.)

ANTARCTICA
INTERNATIONAL LAND OF SCIENCE





BEAKFUL FOR BABY. At the start of the Antarctic autumn vast colonies of Emperor penguins gather on the coasts of sixth continent and nearby islands to mate. During the winter polar night these penguins lay their eggs and raise their young. When spring arrives and the youngsters, like the one being fed by mother, are sufficiently mature, the colonies vanish northward. The cycle is reversed for all other penguins which arrive in spring. (See article page 36.)

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15TH YEAR

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COVER PHOTO

Antarctica today is the scene of intensive scientific activity as men from many countries continue the vast investigations begun in 1957 during the International Geophysical Year. Here two scientists working with a French expedition in Adélie Land investigate ice formation by removing sample cones with special tools (story p. 28).

Jacques Masson (c) Expéditions Polaires Françaises

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A FROZEN CONTI

HOWLING WINDS, bitter cold, and a vast white desert of shifting snow, slippery ice and hidden crevasses make all movement a laborious and hazardous enterprise. This is Antarctica against whose inhospitable climate scientists and explorers must prevail in their efforts to uncover the secrets of the icy continent. Photo shows tracked vehicle and sledge of French Polar expedition bogged down in deep snow.

Jacques Masson
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NENT OF MANY PARADOXES

by Georges Laclavère

ANTARCTICA, with a total surface of about five million square miles, covers an area as large as Europe and the United States combined. If one includes the great ice shelves which fill the deep seas and the bays surrounding the continent, another half million square miles must be added to its immensity. Furthermore, in winter the outlying seas freeze over for hundreds of miles, and when the ice pack has reached the limit of its extension, Antarctica becomes a solid mass of more than fourteen million square miles—equal to a quarter of the earth's entire land surface.

Antarctica is the highest of the world's continents. Great mountain chains, with peaks often rising higher than 10,000 feet, crisscross it in every direction. But these mountains are visible as such only around the edges of the continent. As soon as one penetrates a short distance inland they vanish and only the tips of their peaks emerge from the ice.

The entire land relief of the interior is in fact engulfed under a gigantic ice cap. This ice cap mantles Antarctica from the coast inland, rising slowly until it reaches an elevation of 12,000 feet near a point known as the "Pole of Inaccessibility", situated some 600 miles from the geographic South Pole which itself is no more than 9,800 feet above sea level.

The thickness of the ice is greater than four kilometres (two and a half miles) in certain places. Even on an average it is more than two kilometres (one mile) thick. If all the Antarctic ice were to melt, the level of the seas would rise to drown most of the seaports of our planet together with great stretches of fertile coastal plains.

The climate of Antarctica is the severest known anywhere on earth. The world's lowest temperature of -88.3° C (-126.9° F.) has been recorded at Vostok, the Soviet station situated some 800 miles from the coast at an altitude of 12,000 feet. The annual mean temperature along the coast drops to -30° C. (-22° F.) Winds of incredible velocity and violence rage unceasingly across the continent and make the bitter cold even more difficult to bear.

Plant life is practically non-existent save for certain mosses, lichen and algae. Animal life, however, is abundant along the coasts and in the seas. Teeming colonies of seal, penguins and petrel abound, and the ocean waters are rich in plankton and deep sea creatures. (See article page 35).

One of the many amazing features of Antarctica is its shape which is almost a perfect circle. This has an enormous influence on meteorological conditions all over the continent with far-reaching effects throughout our globe.

Two vast seas cut deeply into Antarctica, the Ross Sea and the Weddell Sea. The most southerly point of the former is only 350 miles from the Pole, and it was this route that both Amundsen and Scott took to get to the South Pole. But to do so they had to cross the forbidding Queen Maud range, a precipitous mountain chain whose peaks, towering more than 15,000 feet, are amongst the highest in Antarctica.

Against great odds they made their way through this jagged barrier by following the great glaciers which carry the ice of the polar cap in its slow flow towards the sea. Scott travelled along the Beardmore glacier which is more than 60 miles long and 18 miles wide. Despite its huge size, it is by no means the giant of Antarctica's glaciers.

Between the Ross and Weddell Seas an extraordinary mountain peninsula shaped like a horn extends to the north. It is a prolongation of the Cordillera of the Andes which, when it reaches the southern tip of South America

CONT'D ON NEXT PAGE

Under the polar cap, remains of a desert

at Tierra del Fuego, sinks beneath the waves of the Atlantic Ocean to re-emerge in Antarctica.

A glance at the map of Antarctica may lead one to suppose, as did certain geographers when our knowledge of the continent was much more superficial, that the Ross and Weddell Seas are joined by a channel filled with ice, and that Antarctica is in reality divided into two parts. This gave rise to the much debated question: "Is Antarctica a continent or an archipelago?"

The answer has come only in the past few years as a result of the many expeditions which have explored the area. These expeditions set out to determine what the coastline of Antarctica would look like if the ice were to vanish, by carrying out systematic measurements of the thickness of the ice.

The method used is to set off an explosive charge on the surface. The concussion wave travels down through the ice until it reaches rock when it is reflected back to the surface and the echo recorded on instruments. Since the speed of the concussion wave is known, we can measure the time elapsed between the explosion and the returning echo, and thus calculate how far down the rock lies. As a result of these measurements, scientists now feel fairly sure that the major part of Antarctica is made up of a single rockbed dating back to very ancient times.

However, a separated rock mass has been recently discovered on the edge of the Bellingshausen and Amundsen Seas. This has been found to be of more recent origin and of different composition from that of the rest of Antarctica. It is separated from the main continent by a very deep channel filled with ice several miles thick.

So, despite the fact that since the start of the International Geophysical Year in 1957 scientific expeditions have undertaken numerous soundings, our knowledge of the topography and geology of Antarctica's hidden rock masses is still uncertain, and many enigmas remain unfathomed.

Thus, the recent discovery that certain portions of Antarctica's coastline are very similar to those of South Africa has raised anew Alfred Wegener's theory of continental drift. (1) Again, carbon deposits have been found which indicate that in former geological times Antarctica enjoyed a hot and humid climate. Elsewhere, vestiges of an arid burning desert intrigue geologists.

Just as ash and sand have preserved civilizations of the past so the Antarctic ice has served to protect the history of the Earth.

Better still, the snow turned to ice and slowly deposited on the surface of Antarctica may soon tell us the story of the evolutions of climate during the course of many millions of years. Tests carried out on ice crystals with radio isotopes now enable scientists to distinguish between the different seasons, and so it will soon be possible for us to know the temperatures that existed in Antarctica when the ice crystals were formed aeons ago. Here, indeed, are the real archives of our planet, and neither natural forces nor vegetation nor human influences have altered them.

For how many hundreds of thousands of centuries have volcanic ash and the dust of meteorites been deposited here ? Perhaps they hold the key to the intriguing puzzles of the Ice Ages and their causes, and the mysterious vicissitudes of climate.

But let us leave this subject of the distant past, fascinating though it is, and return to the Antarctica of today which is of no less interest.

If the amount of the ice in Antarctica should increase it will be at the expense of the waters of the ocean, the level of which will drop. If, instead, the ice diminishes the oceans will benefit from this and, as already noted, the seas will rise. The danger, of course, is in no way imminent, yet a rapid melting of the ice is not at all inconceivable and would have incalculable repercussions on the state of our world economy.

Scientists have therefore been attempting to find out whether the balance sheet for Antarctica's ice is positive or negative. To do this, they calculate the amount of water vapour which the winds blow over Antarctica from the surrounding oceans where it then falls as snow. At the same time, they also calculate the losses, that is, how much snow is driven into the sea by the winds, how many icebergs "calve" or break off from the ice cap and drift away, how much ice melts on the surface of and within glaciers, etc.

The findings have been most contradictory. Certain scientists claim that Antarctica's mass of ice is stationary. A number of observations prove without possible doubt that the line of coastal ice is definitely receding. But the correlation of all the data assembled since the International Geophysical Year was launched tends on the contrary to show an *increase* in the amount of ice. This increase corresponds to an annual condensation in the Antarctic equal to a film of water three millimetres (about one eighth of an inch) thick taken from all the oceans of the world. Yet there is no trace of such a drop in the level of the oceans from any of the hundreds of coastal observation stations which carry out daily testing throughout the globe.

Of more immediate importance are the problems of meteorology in Antarctica which can be summed up in two questions: 1) What is the role of the Antarctic continent on the general circulation of the atmosphere? 2) How does the Antarctic influence air circulation globally?

The South Polar region probably holds more than 90% of the world's supply of permanent ice. It is thus an enormous reservoir of cold temperature and acts on the earth's climate by cooling the masses of air which circulate above its surface as well as the waters surrounding it. In addition, the circular shape of the continent, with the Pole as its centre, increases air circulation in the area. The winds reach fantastic velocities, churning the seas into mountainous waves all along the 40th parallel, and it is no wonder therefore that seamen refer to this part of the world as the "Roaring Forties."

These winds provoke the transfer of heat (or cold) between Antarctica and the rest of the planet. But to what extent? This can only be determined by a minute and prolonged study of Antarctica's meteorology. And one of the most important contributions to a better understanding of our planet during the I.G.Y. was no doubt the setting up of a network of 57 meteorological stations on the continent and the islands of the sub-Antarctic zone.

Most of these stations are still in operation today. An international meteorological centre to assemble and analyse their data was created in Melbourne, Australia, after the central meteorological post at "Little America V" was closed down at the end of the Geophysical Year.

But science's interest in Antarctica is by no means limited to geology, glaciology and meteorology. Like the Arctic, which it resembles in many ways, it is an ideal place for the study of the upper atmosphere and the complex phenomena caused by solar radiation and solar particles under the influence of the earth's magnetic field.

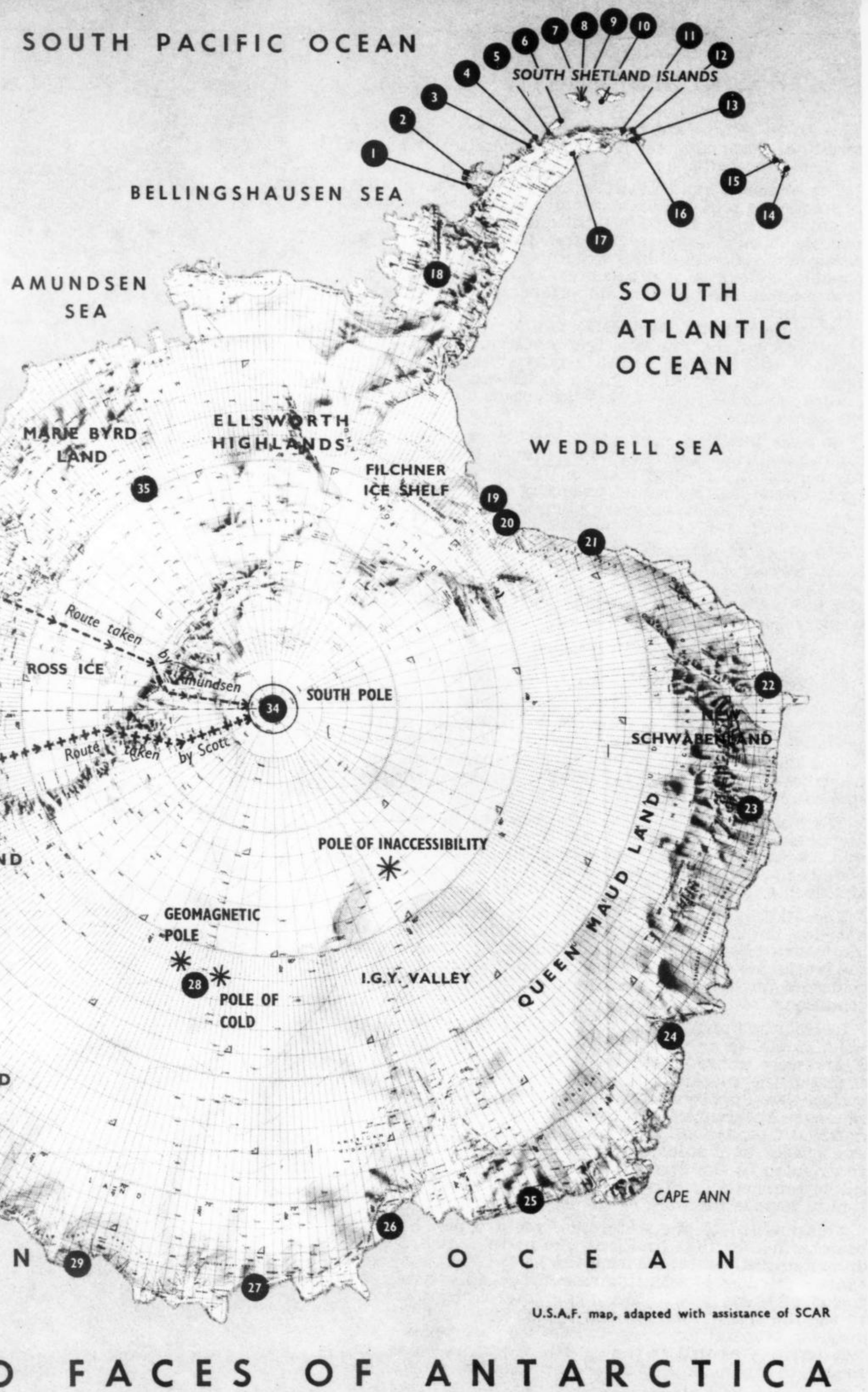
These studies alone would have justified the extraordinary efforts made by the twelve nations who participated in the International Geophysical Year programme.

CONT'D ON PAGE 8

(1) Editor's note: *How the continents originated and came to occupy their geographic positions has from early times been a subject of controversy. In* 1915 *Alfred L. Wegener of Germany set forth his theory of continental drift in his book* The Origin of Continents and Oceans *(published in English translation in* 1924*). According to Wegener, the continents were separated from an original continuous or nearly continuous land mass by drifting apart and a shifting of the poles. Wegener spoke of a general westward movement and a drift of the continents away from the poles. The way in which the bulge of South America can be fitted into the coast of West Africa was offered as supporting evidence for the theory.*

From " Secrets of Antarctica " by Dr. Raymond J. Adie, " New Scientist ", May 25, 1961

ICE-LESS ANTARCTICA. This map of Antarctica shows perhaps one of the most startling geographical discoveries of the century—how the continent would look if all the ice melted. Marie Byrd Land would be reduced to a series of islands separated from the mainland by a 500-600 km. channel. Freed from the tremendous weight of ice, the continent would rise a total of 500 to 600 metres.



U.S.A.F. map, adapted with assistance of SCAR

THE TWO FACES OF ANTARCTICA

Stations occupied, winter 1961, below latitude 60° south

1. - Stonington Island (U.K.)
2. - Adelaide Island (U.K.)
3. - Argentine Islands (U.K.)
4. - Port Lockroy (U.K.)
5. - Gonzalez Videla (Chile)
6. - Melchior (Argentina)
7. - Deception Island (U.K.)
8. - Decepción (Argentina)
9. - Aguirre Cerda (Chile)
10. - Arturo Prat (Chile)
11. - Bernardo O'Higgins (Chile)
12. - View Point (U.K.)
13. - Esperanza (Argentina)
14. - Orcadas (Argentina)
15. - Signy Island (U.K.)
16. - Hope Bay (U.K.)
17. - Matienza (Argentina)
18. - Fossil Bluff (U.K.)
19. - Ellsworth (Argentina)
20. - General Belgrano (Argentina)
21. - Halley Bay (U.K.)
22. - Norway station (South Africa)
23. - Novolazarevskaya (U.S.S.R.)
24. - Syowa (Japan)
25. - Mawson (AUS.)
26. - Davis (AUS.)
27. - Mirny (U.S.S.R.)
28. - Vostok (U.S.S.R.)
29. - Wilkes (AUS.)
30. - Dumont d'Urville (FR.)
31. - Hallett (N.Z.-U.S.A.)
32. - Amundsen-Scott (U.S.A.)
33. - Scott (N.Z.)
34. - McMurdo Sound (U.S.A.)
35. - Byrd (U.S.A.)

Station Data supplied by SCAR

FROZEN CONTINENT *(Cont'd)*

Now these efforts are being continued year after year under the auspices of the Scientific Committee of Antarctic Research, better known as SCAR.

The economic value of Antarctica, apart from whaling, is practically nil. The only resource which seems to exist in any abundance is coal but its exploitation hardly seems feasible. The real wealth of the Antarctic lies in the ocean and the living things within it. It is not at all impossible to conceive that this great reserve of protein rich food may one day play an important part in nourishing our planet.

Many suggestions have been made to put the Antarctic to use, some quite fantastic and crackpot. One idea put forward was to turn it into a cold storage warehouse. Stocks of meat would be frozen in icebergs which when needed would be towed across the oceans for delivery to the consumer.

Another idea has been to fly sealed containers with radioactive waste from nuclear factories to the heart of the continent and drop them on the ice cap. The slow creep of the ice flow would not bring them to the ocean before several thousand years when they would have lost most of their radioactivity and become harmless.

The creation of trans-Antarctic airlines has been envisaged between South Africa, South America and Australia, but the estimated commercial traffic would hardly justify the highly expensive installations which this scheme would require.

THE world now celebrates the 50th anniversary of the conquest of the South Pole by Amundsen and his companions on December 14, 1911, reached only a few weeks later by Scott and his party who met a tragic fate. How much progress we have seen in the short span of 50 years!

The expedition of Admiral Byrd, and the international Maudheim expedition in which Great Britain, Norway and Sweden took part, to cite only these two examples, were the prelude to the parties which set out for Antarctica during the International Geophysical Year.

The IGY expeditions reaped a rich scientific harvest but let us not forget that they embodied the most impressive effort of international scientific co-operation the world has ever seen despite the most inhospitable continent on the globe and the most inhuman of living conditions.

In 1955 the Special Committee of the IGY decided to set up a special group to prepare an Antarctic programme. Fears were expressed that political difficulties might threaten the success of the project. But all such difficulties were happily overcome and every scientific conference on Antarctica, before, during and after the International Geophysical Year has taken place in a friendly atmosphere of mutual understanding which has greatly contributed to the success of all scientific undertakings. All governments tacitly agreed not to allow political factors to impede the work of the expeditions.

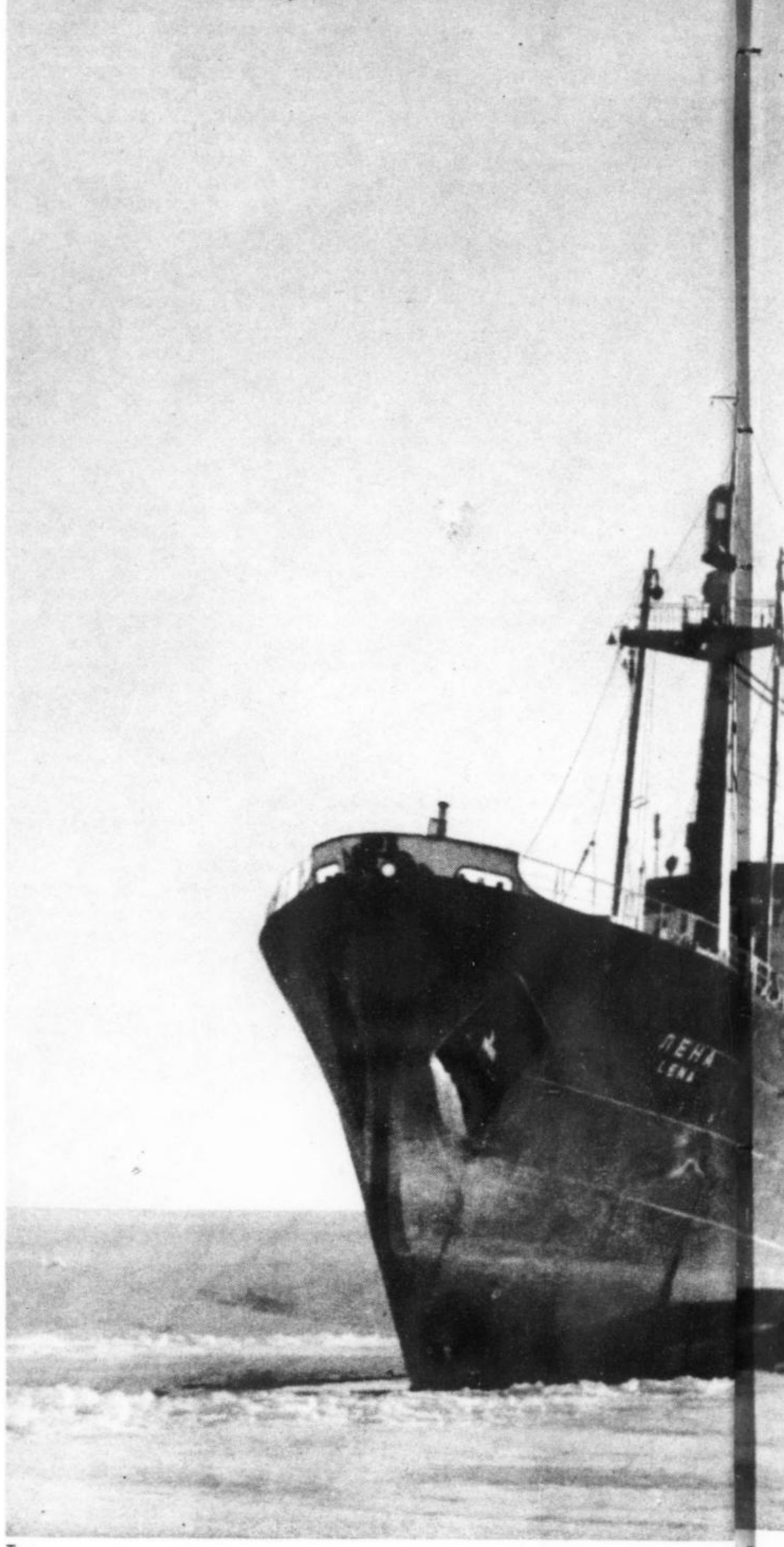
This has led to the Antarctic Treaty which has now been ratified by the 12 nations who had dispatched expeditions to the Antarctic during the IGY. The treaty guarantees freedom of scientific research in Antarctica for a period of thirty years. The signatory countries promise to use the treaty zone defined by the 60° South Parallel only for peaceful purposes, to ban nuclear explosions in this territory as well as the deposit of atomic waste, and finally, to exchange their programmes and scientific data.

This is the first treaty ever drafted to protect scientific research and to entrust a non-governmental organization, the Scientific Committee of Antarctic Research of the International Council of Scientific Unions, with full power to determine the programmes. Here is a precedent and the pattern of a concrete formula for harmonizing relations between science and governments. Is it not a paradox that the continent most hostile to man should be the one to have done the most for the cause of peace.

GEORGES LACLAVÈRE *is president of the Scientific Committee for Antarctic Research and served on the Special Committee for the International Geophysical Year. He is head of the Department of Cartography at the National Geographic Institute, Paris.*

ANTARCTICA, I

Co-operation between twelve nations during the International Geophysical Year made possible the most ambitious scientific exploration yet carried out in the continent of Antarctica. Here, the "Lena" unloads supplies and equipment for the Soviet expeditions' Antarctic stations.



Tass

A, INTERNATIONAL LAND OF SCIENCE

by Ross C. Peavey
& Laurence M. Gould

Long a mystery, later the scene of adventure and exploration, and finally an area of the world whose principal product is fundamental scientific information: this is the history of Antarctica. The last and most important stage has been characterized by international scientific co-operation for the benefit of mankind without the intrusion of political tensions and national rivalries so prevalent in other regions of the world.

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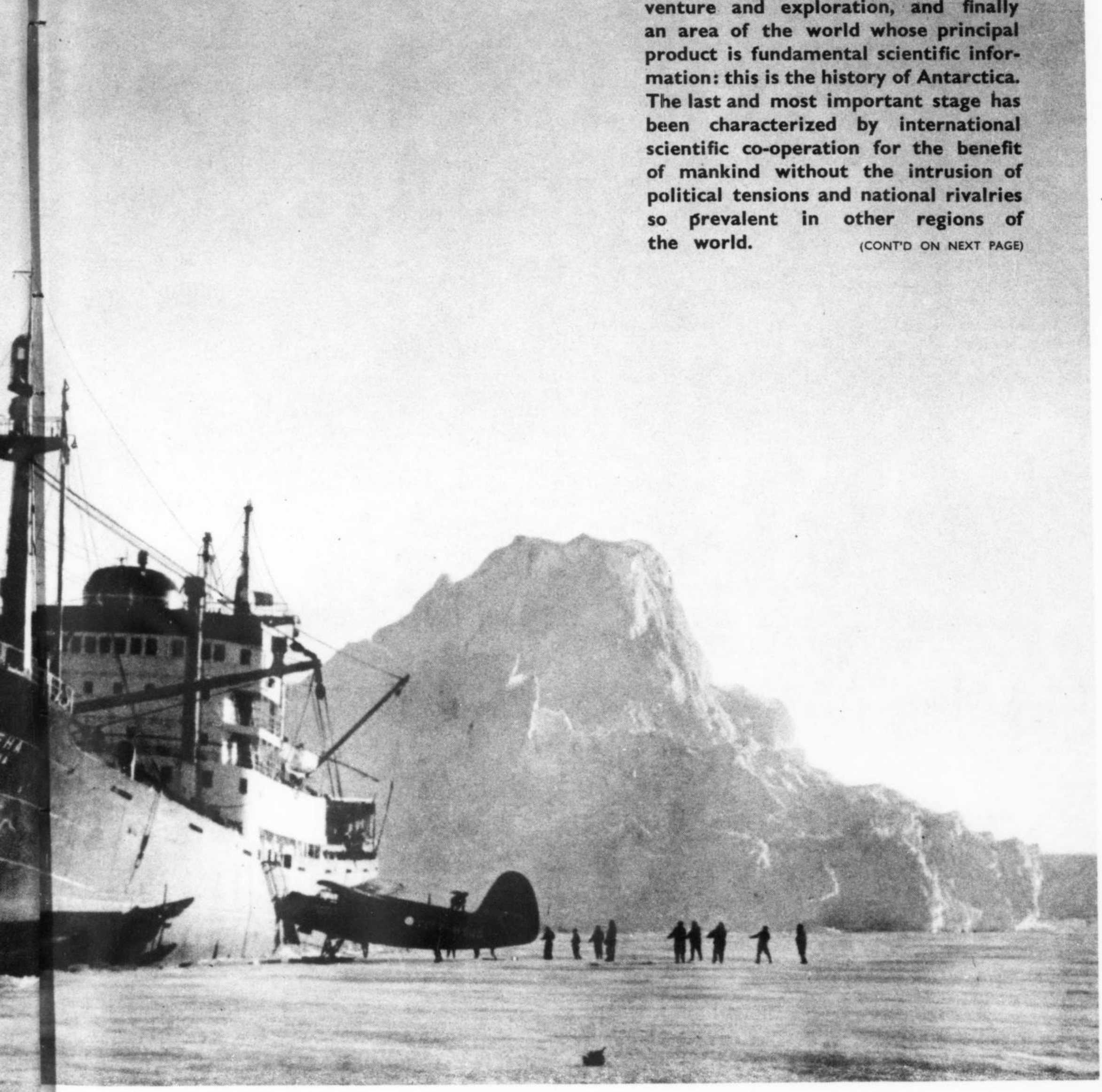


A TREATY WITHOUT PRECEDENT IN MODERN WORLD HISTORY

The culmination of Antarctic collaboration took place on December 1, 1959, when a 12-nation treaty was signed at Washington, D. C., ensuring that Antarctica will continue to be used for peaceful purposes only. The Antarctic Treaty, unique in modern diplomatic history, must be listed as one of the more important results of the International Geophysical Year (IGY) of 1957-1958.

The IGY, man's most ambitious attempt to understand better his physical environment, inevitably focused much attention on Antarctica. The IGY was an endeavour to observe our whole planet and the atmosphere that surrounds it; to ensure a global picture, it was necessary to enlist the co-operation of the scientists of all nations and to co-ordinate their observations. Full geographic coverage demanded specific data from the southern continent. Thus it was that the global aspect of the IGY led to the scientific investigations which opened up Antarctica, and to the international collaboration which has been the essential ingredient in scientific understanding of the Antarctic.

In recent years international scientific collaboration has assumed new meanings and importance, now widely recognized by national leaders throughout the world. For this reason, and because of the growing recognition of the need for even greater knowledge of the world in which we live, it is profitable to examine the history of the Antarctic scientific programme, the factors which have contributed to its extraordinary success, and to look toward the future.

The Antarctic research programme of the International Geophysical Year was the first large-scale and concerted international effort to investigate the scientific secrets of this vast unknown continent and its environs. Nevertheless, the numerous expeditions of geographical exploration and scientific study conducted in the decades

La Uruguay, Argentine vessel which rescued the crew of the Swedish ship, *Antarctica*, trapped in southern ice pack in 1903, is shown on this stamp issued on 50th anniversary of *Uruguay's* exploit.

before the IGY provided scientific contributions of great value which can never be discounted in the unfolding scientific knowledge of the continent.

Some of these expeditions were, in fact, primarily scientific in purpose and several were international in character (in recent history, for example, one should note the collaborative work of the Norwegian-British-Swedish Antarctic Expedition of 1949-1952, the British-Australian-New Zealand Antarctic Research Expedition of 1929-1931 and the British-United States Wilkins-Hearst Antarctic Expedition in 1928-1929).

The work of scientists on all of these previous expeditions provided an invaluable base on which to develop, as a major part of the IGY programme, a co-ordinated attack in the geophysical sciences in Antarctica. Here, in particular, factors of terrain, inhospitable environment, remoteness, and the great size of the unknown area clearly postulated an international approach for the programme. These factors are related so directly to the guiding principles upon which the whole IGY programme was based that it may be useful briefly to consider these principles for international scientific co-operation in science in the context of an Antarctic programme. In summary, they are:

- Scientific knowledge derives from the synthesis of ideas, principles, and research developed by able scientists of all nations.
- Science develops best in the environment of free communications.
- Direct access to things and processes in nature is fundamental to basic scientific advances.
- Common standards of observation and measurement and a common pool of basic data are essential for the description and understanding of the physical phenomena under investigation.
- Means for full co-operation among scientists have become necessary for detailed observation of varying phenomena, a criterion particularly applicable to the study of transient geophysical phenomena.

Antarctic penguin and Japanese Antarctic ship, *Soya*, figure on this 1957 stamp issued to mark part played by Japan in the IGY Antarctic research.

Modern means of transportation and communication and many post-war developments in scientific instrumentation facilitated application of these principles and thus made possible a concerted programme of geophysical research in the Antarctic during the International Geophysical Year.

From the start of the planning, international co-operation and a willingness to adjust national programmes for common goals prevailed in the development of the IGY Antarctic programme. First, scientists of each country prepared their own plans to implement IGY objectives. Scientists of many countries (Argentina, Australia, Belgium, Chile, France, Japan, New Zealand, Norway, South Africa, the United Kingdom, the U.S.S.R., and the USA) then met in a series of regional conferences to exchange information on these plans and to consider necessary adjustments.

Belgian explorer, Adrien de Gerlache, who led an Antarctic expedition in 1897, is seen on stamp by which Belgium commemorated expedition's 50th anniversary.

As in the global IGY programme, the spirit of international collaboration and scientific give-and-take, in the common interests of the maximum Antarctic research effort, was notable. Mutual problems were discussed and resolved, gaps in station coverage of Antarctica were defined and voluntarily filled by increased programme efforts of several countries, mutual logistics-support arrangements were outlined, and a

successful plan for interstation radio communications was established.

Similarly, the actual IGY Antarctic operational programme was replete with occasions of international collaboration. Space does not permit recounting all of these occasions, but a few of the more significant should be briefly cited. An IGY International Antarctic Weather Central was established, not only to permit immediate research in Antarctic meteorology but also to permit the regular development and dissemination of daily weather forecasts so important to all of the Antarctic stations in the day-to-day conduct of their research and logistics operations. Although operated by United States scientists, the Weather Central was truly international in character with scientists from Argentina, Australia, France, New Zealand, Union of South Africa and the U.S.S.R. participating fully in its work.

A programme for the exchange of scientists was instituted, whereby research workers of one country joined in the programmes of other countries, thus enabling a free and prolonged exchange of scientific information, experience in working with different equipment, and mutual collaboration in standardization or interpretation of data.

The Antarctic radio communications network proved effective in many ways: meteorological data were rapidly collected for use by the Weather Central and forecasts then disseminated; warnings of significant geophysical

Norway's Antarctic territory, Queen Maud Land, is shaded area on the map of the continent seen in this stamp marking Norway's contribution in IGY Antarctic research.

events were promptly distributed throughout the continent; mutual scientific problems were discussed; and emergency situations were made known where common assistance could be of help.

Several countries conducted scientific traverses, each for their own specific research objectives with common scientific goals, but all contributing to a comprehensive understanding of the extent of the vast Antarctic ice cap which covers the continent and to a delineation of the underlying terrain features.

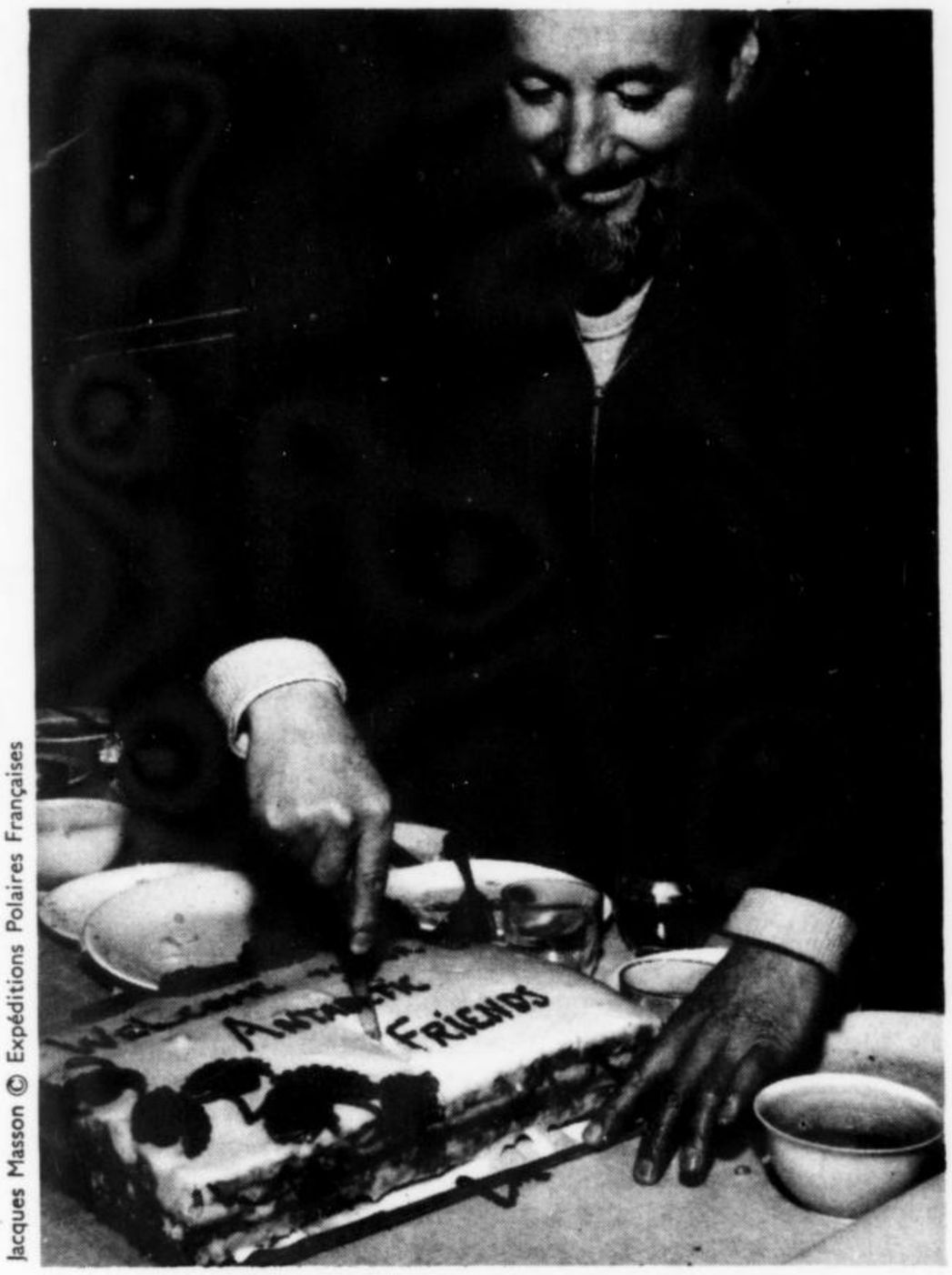
In some cases stations were operated jointly, as in the case of the Hallett Station at Cape Adare where New Zealand and United States scientists have now collaborated for some five years.

Perhaps most illustrative of international co-operation in Antarctica and the surrounding oceans is the direct logistics assistance given to other expeditions; the record of the scientific effort in this region is full of examples in which nationality had no part—of icebreakers relieving ice-bound ships or aircraft flying to the rescue of beleaguered personnel.

Although it is not the purpose of this article to recount or evaluate in detail the scientific findings in Antarctica since the inception of the IGY, it is profitable to summarize at this point three significant contributions of the programme.

First, the purely scientific results, and their scientific meanings, both regionally and globally, have been unparalleled in history.

Second, quite aside from the importance of the research investigations themselves, these findings are destined to



Jacques Masson © Expéditions Polaires Françaises

ROSES IN THE ANTARCTIC, but in this case on a cake being cut by Phillip Law, of Australian Antarctic Expedition. Cake was baked for a reception given to Australia's Antarctic team at French base of Dumont-d'Urville.

have practical impacts of great value. Here it is only necessary to suggest the progress already occurring in the understanding of Antarctic meteorology and the consequent improvements to Southern Hemisphere weather forecasting, or the advances to be anticipated in radio communications through our increased understanding of physical processes in the Antarctic upper atmosphere and ionosphere.

Third, international collaboration in the programme has led to the close and personal association of able scientists from many countries, associations which, unimpeded by political restraints, have been down-to-earth and have led to lasting friendships and scientific associations, mutual appreciation of problems and goals, and perhaps even in some measure, to the relaxation of current-day political tensions.

Fourth, successful negotiation of the Antarctic Treaty.

As the Antarctic scientific programme progressed, it soon became apparent that the scientific discoveries were coming too fast and their significance, both regional and global, was too great to stop with the official termination of the IGY research effort. Much had been learned, but scientists in many fields recognized that the search for scientific knowledge had only begun. Moreover, great effort and investments in station facilities and scientific equipment had been made, which could be capitalized upon to continue the programme at relatively little extra cost.

Consequently, even during the first months of IGY, recommendations were made to the International Council of Scientific Unions (ICSU), that a means be found to sustain international scientific co-operation in Antarctic research following the close of the IGY. The ICSU responded by establishing a Special Committee on Antarctic Research (SCAR) with representation provided by interested constituent scientific unions and by the scien-

CONT'D ON NEXT PAGE

WORLD ROSTER OF SCIENTISTS

tific academies of the twelve countries already conducting Antarctic research.

As in the IGY programme, SCAR has preserved and extended the character and conduct of international co-operation in planning and implementing Antarctic research. The close personal relations initiated during IGY among scientists of many nations have been cemented in the continuing SCAR deliberations and have been valuably augmented by a growing body of participants with first-hand Antarctic experience.

Through working groups in each principal scientific field SCAR has built upon and extended the IGY programme of research. New programmes in the fields of biology, geology, and cartography have been added to those in geophysics. At each SCAR meeting the status of the scientific programme is assessed and modified as necessary, so that scientists of all participating countries are working toward common goals with mutual international scientific appreciation of the programme aims.

In several fields SCAR has initiated new efforts in international collaboration. A SCAR international register of scientists has been established by which research workers from any country can make their interests in Antarctic research known to the planners in countries already conducting programmes; this register, although only established in recent months, affords a real opportunity to find and utilize mature and able scientists to best advantage in research without regard to their national origins.

At its fourth meeting in September 1960, SCAR recognized the special problems of nature conservation occasioned by continued human activity in the Antarctic. SCAR noted the Antarctic environment as one of the important bio-geographical regions of the world from a scientific standpoint and developed a series of recommendations for international co-operation in protection and conservation of its unique life forms.

SCAR early made arrangements for continuation of the IGY International Antarctic Weather Central as a permanent part of the post-IGY scientific programme; with the collaboration of the Australian Meteorological Service, a permanent International Antarctic Analysis Centre was established at Melbourne in 1959. This Centre, continuing the work of the IGY Weather Central, is placing greater emphasis on basic meteorological research and its southern hemispheric effects. To date, scientists from Argentina, Australia, France and the United States have participated in the work of the Analysis Centre.

In related fields also, SCAR has taken measures to collaborate with other international programmes in geophysics: the World Magnetic Survey, the ICSU international programme for the Year of the Quiet Sun, studies of the earth's crust and upper mantle, and the SCAR Indian Ocean Expedition are particularly noteworthy in this regard.

Thus, through many avenues SCAR has recognized the urgent need for international scientific co-operation in Antarctic research. As in the IGY, such research becomes the vehicle by which scientists of many nations, collaborating fully and freely, can provide the common ingredient so necessary to further scientific understanding of the region.

Political leaders throughout the world have recognized the unique qualities of the Antarctic research programme and, in 1958, moved to preserve this amicable accord. Upon the invitation of President Eisenhower, representatives of the 12 nations then conducting Antarctic scientific investigations met to develop the terms of a treaty which, in the words of the President, would promote:

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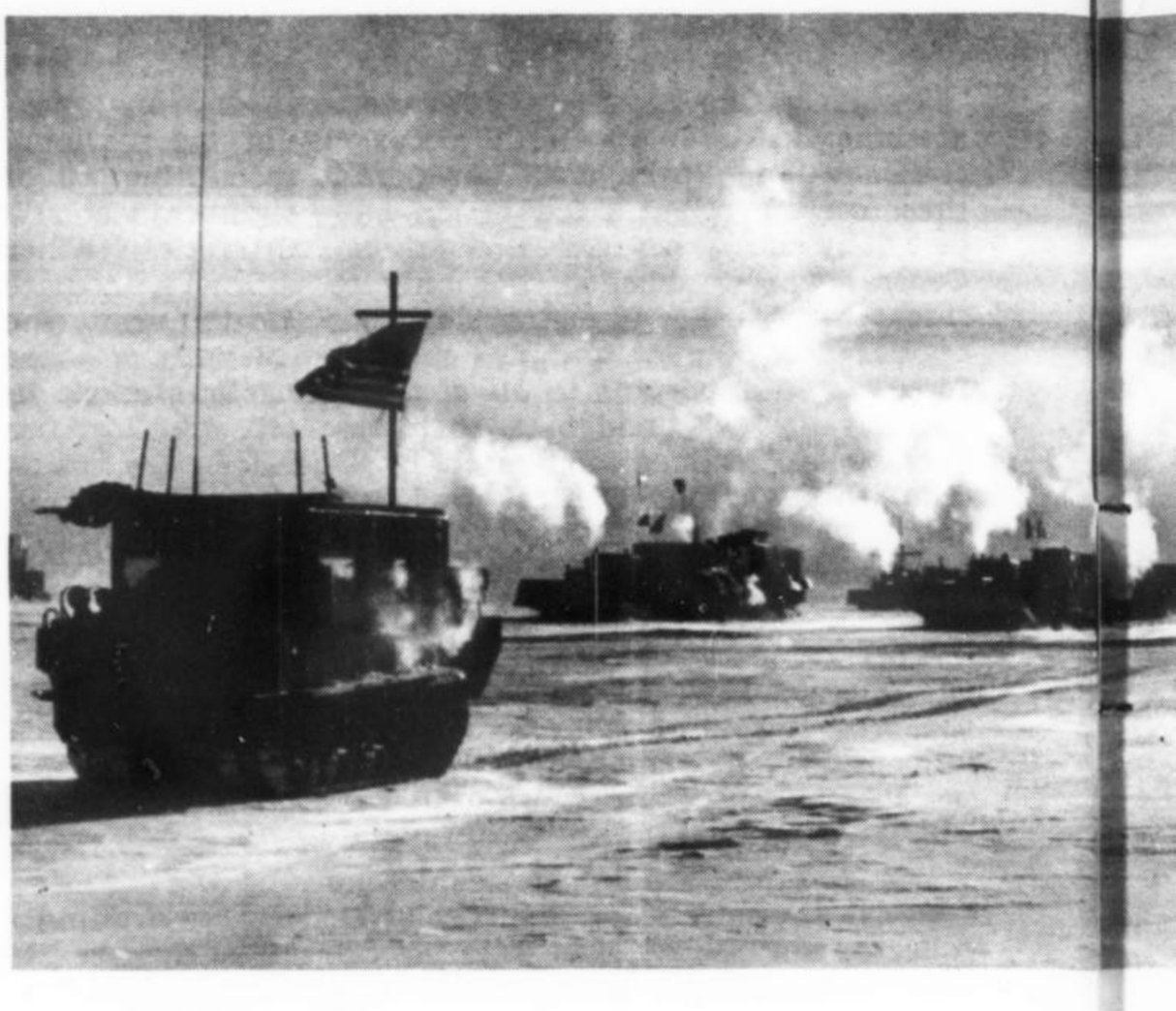


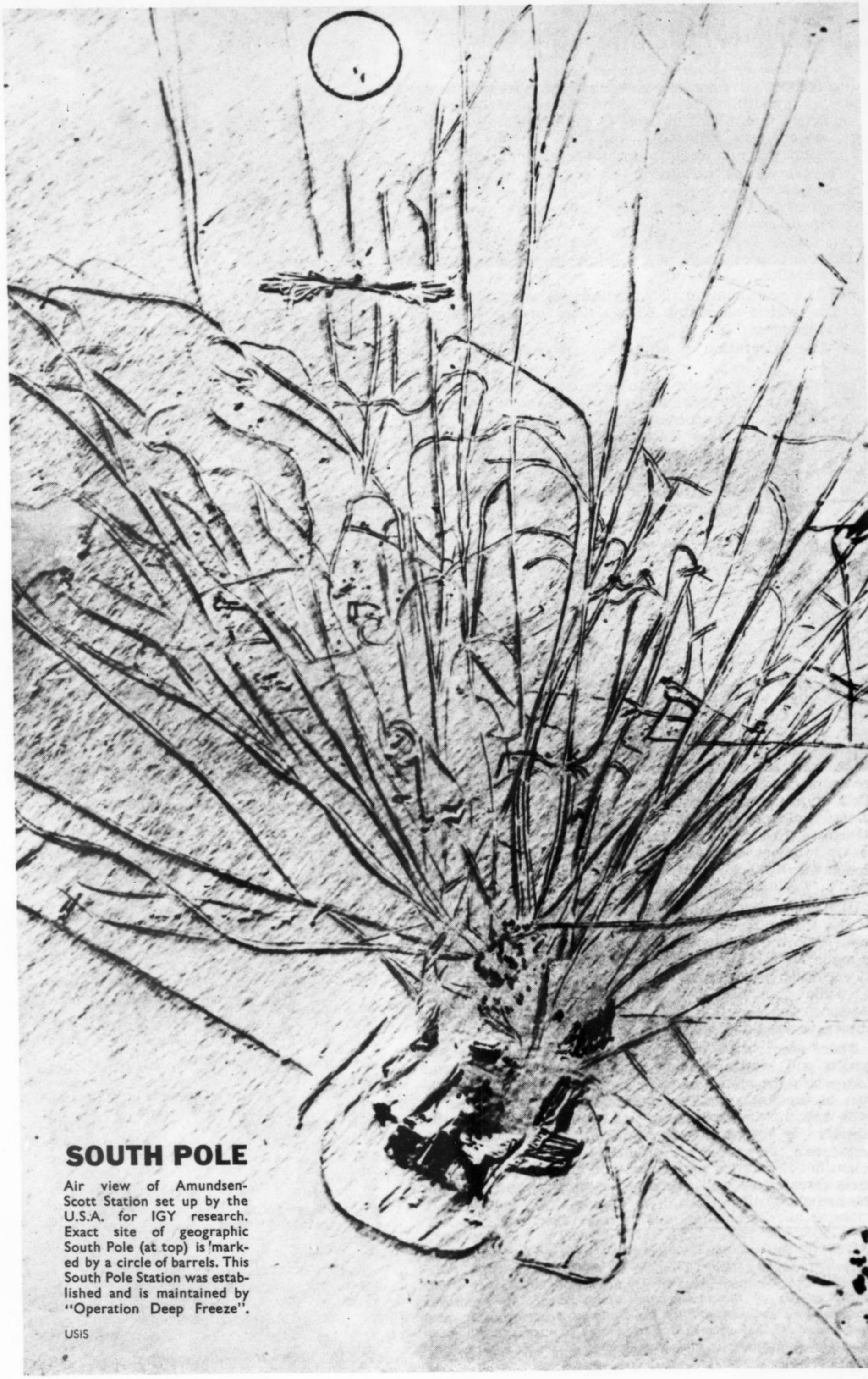
ARMADA OF PEACE

A U.S. Navy tractor team (above) leaves Little America on a 600 mile trip to a scientific base in Marie Byrd Land. Right, an American photographer-scientist learns about Antarctic weather the hard way when caught in a three-day blizzard. Note face mask coated with ice. Below, international solidarity of science : Soviet and U.S. explorers meet at the South Pole (shown opposite).

USIS

A. Maximova-Soviet photo

U.S. Navy



SOUTH POLE

Air view of Amundsen-Scott Station set up by the U.S.A. for IGY research. Exact site of geographic South Pole (at top) is marked by a circle of barrels. This South Pole Station was established and is maintained by "Operation Deep Freeze".

USIS

NUCLEAR EXPLOSIONS BANNED

"Freedom of scientific investigations throughout Antarctica by citizens, organizations and governments of all countries; and a continuation of the international scientific co-operation which is being carried out so successfully during the current International Geophysical Year."

These overtures resulted in an Antarctic treaty conference which convened in Washington, October 15 to December 1, 1959. The product was the Antarctic Treaty, agreed to by representatives of all twelve nations, and now ratified by all of them. The treaty contains the following important principles governing future activities in Antarctica:

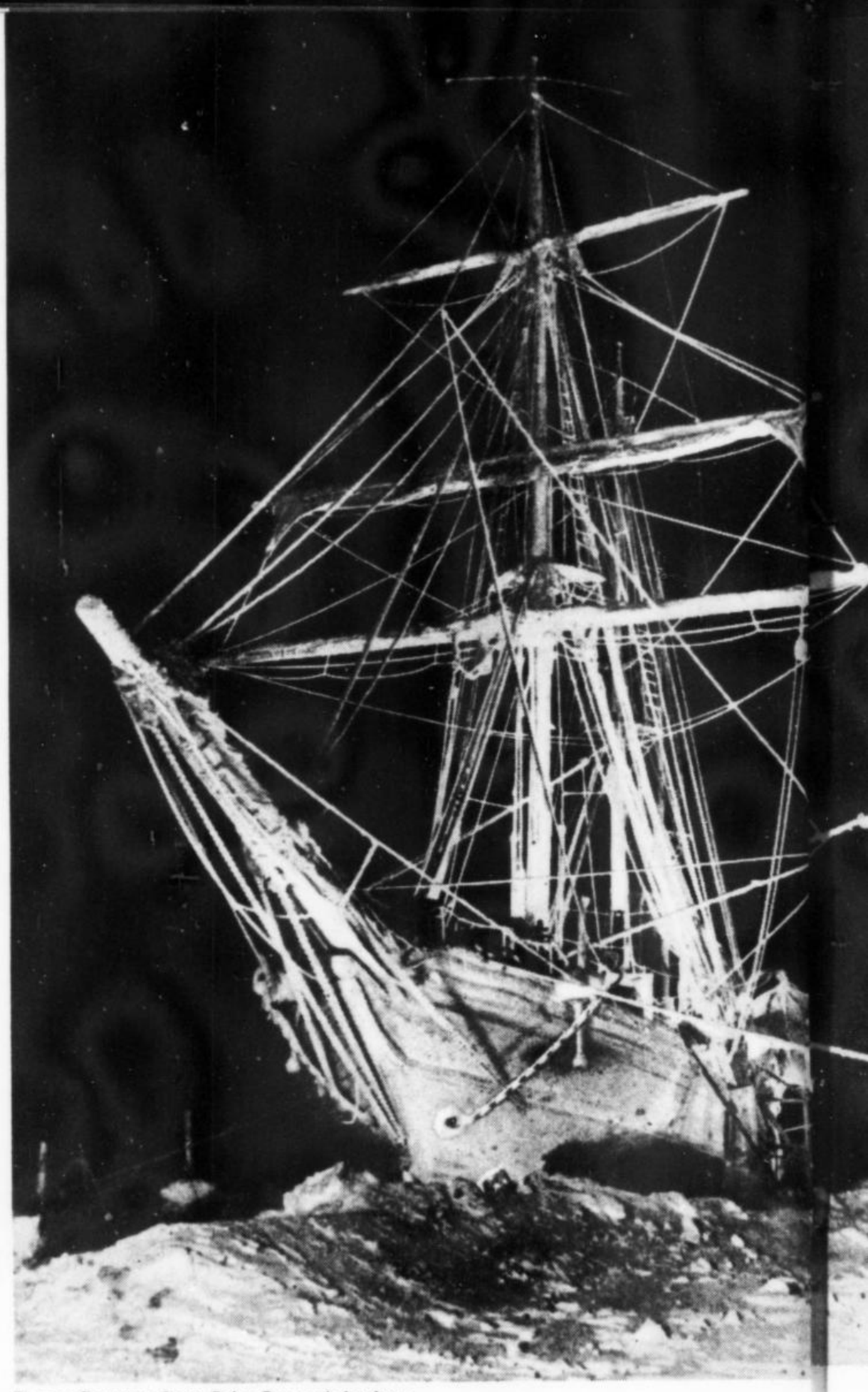
- The continuation of international scientific co-operation which characterized activities of the IGY and SCAR programmes.
- The reservation of Antarctica for peaceful purposes only.
- Preservation of the status quo on all national territorial claims for 30 years and a provision that no scientific activity during this period shall be used as the basis for asserting a claim.
- The prohibition of activities for military purposes and the prohibition of nuclear explosions, and
- A system of free inspection of any part of Antarctica by observers of signatory nations.

THE successful negotiation of the Treaty can only be ascribed to the groundwork in international collaboration laid by the world's scientists in planning and undertaking the comprehensive Antarctic scientific programme of the IGY and the following years. Especially during the decade preceding the IGY, several nations had attempted to secure international agreements on Antarctica through negotiations within the United Nations. All of these attempts had foundered on the troublesome problems of territorial claims and for want of the harmonious and co-operative international arrangements developed by the IGY and SCAR programmes. This unprecedented contribution by science to international diplomacy was widely acknowledged by national delegates throughout the Treaty negotiations and, indeed, is the theme of the preamble of the formal Treaty document.

It is not surprising, therefore, that continued international co-operation in Antarctic scientific investigations is also the central theme of the Treaty Articles of Agreement. During the 30-year tenure of the treaty, provision is made for full international exchange regarding national scientific programmes in Antarctica, the exchange of scientific personnel between expeditions and scientific stations, and the full and free interchange of scientific observations and results.

There seems little doubt that new scientific data and results will continue to be the principal export from Antarctica for many years to come. Successful negotiation of the Antarctic Treaty acknowledges science as its goal, and the Treaty Agreements preserve the favourable climate for international scientific activities. Thus, in Antarctica the coming years should continue to produce scientific discoveries and results of great significance to basic research as well as many practical applications for the benefit of all.

ROSS C. PEAVEY AND LAURENCE M. GOULD *are respectively executive secretary and chairman of the Committee on Polar Research U.S. National Academy of Sciences. Dr. Peavey is one of the editors of the two-volume study,* Science in Antarctica *produced by the Committee for the National Academy of Sciences (Publication N°. 839 and 878). Dr. Gould has led expeditions to the Arctic and Antarctic and was director of the U.S. Antarctica programme during the IGY.*



Photos Courtesy Scott Polar Research Institute

DISCOVERY EXPLORATION ADVENTURE & COURAGE

by G. de Q. Robin

EPIC OF ENDURANCE

ERNEST SHACKLETON made three attempts to reach the South Pole; all failed—the last, at least, one of the greatest undertaken by man. On December 5, 1914, the Endurance with the British Imperial Trans-Antarctic Expedition on board left South Georgia and almost immediately met pack ice unseasonably far north. The ship was immovably trapped (left).

Shackleton realized that they would have to spend the winter locked in the ice, but after midwinter the ice began to break up and move, creating pressure waves capable of crushing the defenceless ship like an egg-shell. On October 27 the ship was abandoned and camp set up on an ice floe.

The Endurance did not finally sink until November 24, and by then a large part of the stores and equipment had been cleared. Shackleton planned to sledge to Paulet Island, 346 miles away off the north-west coast of Graham Land, where a hut and stores left by previous expeditions were to be found. The 28 men and their dogs began the long journey hauling sledges and three small boats over the rough ice, but the party was soon forced to stop and drifted northwards until end December 1915. Another attempt to move towards land again failed.

Towards end March the floe began to break up. On April 9, James Caird, the whaler, and the two cutters were launched. Five days and nights of bitter hardship followed as they fought their way through ice suffering miseries from thirst and exposure— wet, sea-sick and frozen.

At last Elephant Island, one of the South Shetlands Islands, was reached and they trod on land for the first time since December 1914. Immediately Shackleton began the next operation, to seek help from the nearest feasible point, the whaling station in South Georgia, 800 miles away. With five companions he set out on as hazardous a sea voyage as has ever been attempted by man. The men left behind settled down for what proved to be four months of unremitting privation.

The seas before the James Caird were amongst the stormiest in the world and the ordeal lasted 16 days. When they at last reached the coast of South Georgia the ship was a wreck. Stromness and rescue lay on the other side of the island, over mountains and glaciers never before climbed by man. But nothing could deter Shackleton's determination not to be beaten. Ragged, carrying only a few rations, a carpenter's adze for an ice-pick and 50 ft of rope they set out on May 19, after making a shelter for two sick men unable to continue.

Until the 20th they struggled on in those mountains, following promising slopes that ended in precipices, finally glissading blindly into the mist to reach the valleys on the island's other side It was an incredible feat of mountaineering.

Not until end August, 1916, and then only after three unsuccessful attempts, did Shackleton succeed in returning to Elephant Island to rescue the shore party (photo above).

Condensed from a text by L. M. Forbes

THERE is something terrifying about the idea of a flat earth. Although a few intellectuals knew of the curvature of the earth from the time of the early Egyptians and Greeks, it is nevertheless reported that some of the sailors under Christopher Columbus were afraid of drowning in a cataract of water pouring over the edge of the world.

Columbus himself pictured the earth as a sphere, and the various exploratory voyages of the fifteenth and sixteenth centuries, culminating in the circumnavigation of the world by Magellan, convinced the ordinary man that the earth was round.

The distribution of continents over the northern hemisphere led geographers to postulate the existence of a vast continent in high southern latitudes to preserve the symmetry of distribution of land and sea, as is shown in Wytfliet's map of the world of 1598. It is surprising that some scientists should have supposed this continent to be a fertile, temperate land even as late as 1765, when considerations of climatic symmetry with the icy Arctic regions should surely have been invoked.

In the early seventeenth century, Dutch voyages, culminating in that of Abel Tasman in 1642, showed that Australia did not extend southwards to join this mythical continent. It was however left to an Englishman, James Cook, by his two voyages of 1768-71 and 1772-74 to prove that no extensive fertile continent existed to the south of the known lands, and that if an ice-bound continent did exist, as he considered possible, it must lie mainly to the south of 60° latitude.

Apart from this major conclusion, Cook did much to advance techniques of exploration by the use of sturdy vessels which could withstand damage from the ice or from grounding, and by his careful attention to the welfare of his crew, particularly in regard to foods which prevented scurvy.

Fifty years after Cook's voyages, an active quarter of a century of Antarctic exploration began with the discovery of the South Shetland Islands and with the Russian (Bellingshausen) circumnavigation of Antarctica of 1819-21. During this voyage, Bellingshausen's track supplemented Cook's explorations in that he kept well to the south in those regions where Cook had retreated to the north.

Although he nowhere exceeded Cook's farthest probe south, he did restrict the area of any possible continent to two-thirds the size which could be postulated from Cook's voyage farthest south by penetrating the Weddell the Greenwich meridian and the mountains of Alexander Land about 70° W, he contributed to the idea that a continent, as opposed to a frozen sea, did exist.

Just before Bellingshausen's voyage, the discovery of the South Shetland Islands by William Smith (Great Britain), followed the next year by the sighting of the Antarctic Peninsula by a British expedition under Bransfield and by Nathaniel Palmer, the American sealer, opened up some rich sealing grounds which flourished for a few years before indiscriminate killing made the trade less profitable.

The desire to add new lands to the map, as well as to find seal colonies, resulted in a number of important discoveries by small sealing vessels. Weddell exceeded

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First winter on the icepack

Cook's voyage farthest south by penetrating the Weddell Sea to 74° 15 S with two small vessels, the brig *Jane* of 160 tons and the cutter *Beaufoy* of 65 tons.

John Biscoe circumnavigated the continent during the years 1830-32 in similar ships under trying conditions, during which the effective crew of each ship was at times reduced to three men due to scurvy and other illnesses. He sighted similar rising snow slopes to those seen by Bellingshausen, but thought them caused by the freezing of the sea. He then saw the rock peaks exposed at about 50° E which he named Cape Ann. After retreating to Tasmania during the winter, he discovered the Adelaide Islands near the Antarctic peninsula.

Two other sealing captains, Kemp and Balleny, made further discoveries of land within the Antarctic circle at 60° E and 165° E during this decade, but national expeditions were responsible for the major discoveries during the period 1837 to 1843.

The first of these was the French expedition of 1837-40 under Dumont D'Urville, who worked westwards around the continent from the peninsula. On January 22, 1840, he discovered Terre Adélie in 138° E, and landed there to take formal possession for France. Nine days later he sighted another stretch of coastline, but by one of those strange twists of fortune that occur in Antarctic history, it was found that the United States Exploring Expedition of 1838-42 under Charles Wilkes had sighted the same coast a few hours earlier.

This latter expedition sailed only after considerable public pressure on the United States Government to initiate exploratory activities at least equal to those of European countries. Wilkes claimed the discovery of some 1,500 miles of coastline from around 166° E to 106° E. Although some of the eastern stretch of this "continental" coastline was subsequently shown not to exist, most of his work has proved substantially correct.

The British expedition of 1839-43 sent out by the Royal Society of London and the Admiralty under the command of James Clark Ross, the discoverer of the north magnetic pole, also had the joint aims of scientific investigations and discovery. Ross was given a chart of Wilkes's discoveries and he knew of the work of Dumont D'Urville. Realising that he was unlikely to reach the south magnetic pole by following their tracks, he struck farther east hoping to find a more southerly passage which would lead him to the magnetic pole.

Instead he succeeded in charting 500 miles of the mountainous coastline of Victoria Land, and 500 miles of a floating ice barrier, now called the Ross Ice Shelf, which made further progress to the south by sea impossible. He completed his circumnavigation by adding his contribution to the known islands in the region of the peninsula, in this case on the less accessible eastern coast.

These discoveries by sealing ships and national expeditions were used for Colton's map of the Antarctic in 1855 which showed the outline of an Antarctic continent much as we know it today. In terms of the available ships and techniques, the achievements between 1819 and 1843 were unparalleled.

Interest in the Antarctic dropped during the next fifty years, although commercial activity in hunting the dwindling stock of seals and in exploiting the large whale population continued in sub-Antarctic waters. But a notable contribution was made during this otherwise quiet period by the voyage of the *Challenger* of 1872-76. In addition to this expedition's many contributions to biological and physical oceanography, and its charts of several sub-Antarctic islands, it showed that rocks dropped from Antarctic icebergs on to the ocean bed were typical of a continental origin.

With the twentieth century came steam power, providing a new means of manœuvring ships through pack ice. Stirring appeals at meetings of the International Geographical Union stimulated such activity that expeditions set out from many countries during the twenty years preceeding World War I. In 1893-94, a Norwegian whaling expedition under C. A. Larsen mapped the east

ICE-BOUND Antarctic exploration vessel, the "Gauss", photographed from a captive balloon. The German expedition led by Erich von Drygalski used the balloon to extend the range of observation. Filled with hydrogen it rose to about 1,000 feet from where the observer in its basket could relay information by telephone. This photograph of the "Gauss" in the pack ice was taken by Emile Philippi, on March 29, 1902.

From " Deutsche Sud Polar Expedition ", 1901-1903 by E. von Drygalski. Reimer, Berlin, 1912.

James Cook

F. Bellingshausen

J. Dumont-d'Urville

A. de Gerlache

J. Clark Ross

E. von Drygalski

Julian Irizar

J. Baptiste Charcot

E. Shackleton

Roald Amundsen

R. Falcon Scott

Richard Byrd

TRAIL BLAZERS OF ANTARCTICA

JAMES COOK (1726-1779). British navigator, first to cross Antarctic Circle (1773) and map deep southern latitudes. Failed to find Antarctic land, but believed a frozen continent existed to far south.

FABIEN BELLINGSHAUSEN (1778-1852). Russian explorer, first to reach Antarctica on January 28, 1820 and circumnavigate it between 1819-1821. His ship, "Vostok" was accompanied by the "Mirny" under M. P. Lazareff. He sighted mountains thus confirming that land and not merely a frozen sea existed there.

JULES DUMONT D'URVILLE (1790-1842). His French expedition was first to land on Antarctic terrain on January 22, 1840. He named it Adélie Land.

JAMES CLARK ROSS (1800-1862). Leader of British scientific expedition which charted 500 miles of Victoria Land and 500 miles of floating ice barrier (now named after him) while searching (1839-42) for South Magnetic Pole.

ADRIEN DE GERLACHE (1866-1934) whose Belgian expedition (1897-99) waa the first to winter south of Antarctic Circle.

ERICH VON DRYGALSKI (1865-1949). led German expedition in specially built vessel "Gauss" to carry out important scientific studies (1901-03). Made meteorological and magnetic observations with Scott's "Discovery" expedition.

JULIAN IRIZAR (1869-1935), Argentine naval officer, whose ship "Uruguay" rescued Swedish expedition of Otto Nordenskjold marooned in 1903 after its ship, "Antarctica" was crushed the ice.

JEAN-BAPTISTE CHARCOT (1867-1922). French scientist and explorer, charted large areas of western Antarctica during voyages in 1903 and 1908.

ERNEST SHACKLETON (1874-1922) whose British expedition (1907-09) came to within 97 miles of South Pole and reached South Magnetic Pole. For story of Endurance see page 15. Died while leading a later expedition to Antarctica.

ROALD AMUNDSEN (1872-1928). Norwegian Antarctic and Arctic explorer, he led first party to reach the South Pole (See page 18).

ROBERT FALCON SCOTT (1868-1912) led first parties to penetrate any distance into Antarctica (1901-1904). Reached South Pole one month after Amundsen (see page 19).

RICHARD BYRD (1888-1957). United States explorer and leading figure in development of modern Antarctic exploration methods, employing aircraft and mechanical vehicles. Led three expeditions between 1928 and 1941.

coast of the peninsula to 68° 10' S, and returned unscathed —a feat which has not been repeated so far south on this coast to the present day. The coastline south of this point has been mapped only by aircraft and dog-sledging parties during recent years.

The first major national expedition of this period came from Belgium under de Gerlache in the *Belgica,* with an international complement of scientists and crew, including the mate, Roald Amundsen, who subsequently reached the south pole. The doctor was F. A. Cook, who subsequently claimed to be the first man to reach the north pole, although Peary's claim has since been generally accepted. The *Belgica* was caught for the winter in the pack ice, and the party thus became the first men to winter south of the Antarctic circle

Before the *Belgica* returned, the first expedition to make a planned wintering on the continent had set out in the British vessel "Southern Cross" under Borchgrevink, the Norwegian explorer, with a party mainly consisting of his compatriots. This expedition carried out a planned series of scientific observations at Cape Adare while the ship retired out of the pack ice and returned the following summer, thus setting a pattern which is followed extensively at the present time. Borchgrevink also landed on Ross's ice barrier and sledged a short distance over the ice shelf to reach 78° 50' S, the record at that time. Again, this pattern was widely followed during the next twelve years.

Due perhaps to newspaper rather than official backing, and to some shortcomings in the scientific results, Borchgrevink's contributions to the techniques of Antarctic exploration have been overshadowed, probably unjustly, by the more famous nationally sponsored expeditions of the following four years.

These national expeditions all carried experienced scientific staffs to investigate fields such as biology and geomagnetism, as well as furthering geographical exploration. The German expedition of 1901-03 under Drygalski in the *Gauss* wintered in the pack about 90°E, close to the coastline, which was reached by sledging parties. This expedition, and that of Scott at the same time, sent observers aloft on captive balloons to extend the range of discoveries, but this technique has not since been used.

The Swedish South Polar Expedition of 1901-04 under Dr. Otto Nordenskjold wintered on Snow Hill Island early in 1902 off the eastern coast of the Antarctic peninsula. Their ship, the *Antarctic,* under C.A. Larsen, was unable

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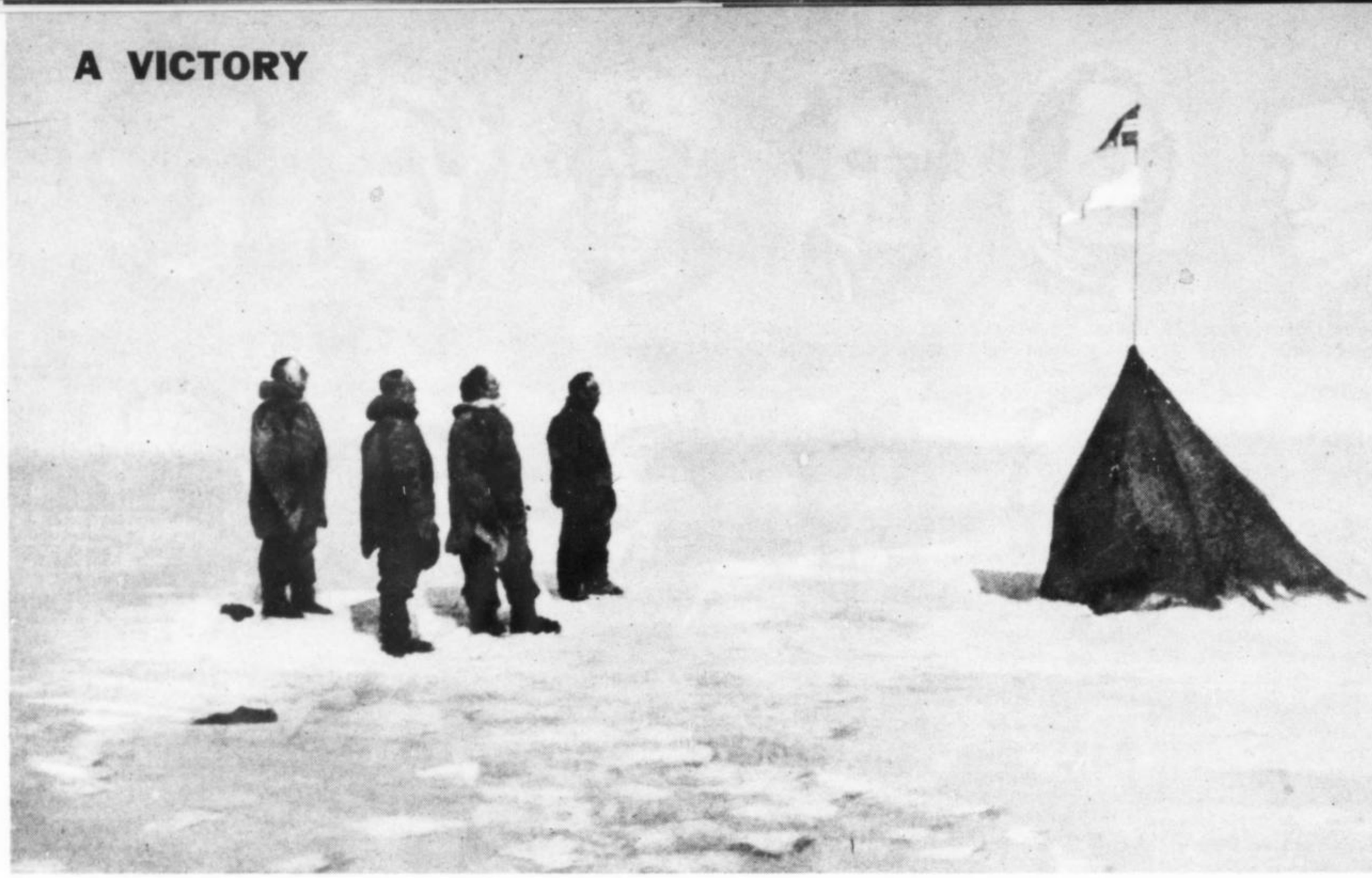
A VICTORY



AMUNDSEN. On December 14, 1911, Roald Amundsen pitched a tent at the South Pole and took this historic photograph of his companions standing bareheaded before Norway's flag. Amundsen's journey had begun in 1910 when he set sail from Norway in the *Fram*, the ship already made famous by the arctic exploits of the Norwegian explorer, Fridtjof Nansen. By February 1911, Amundsen had reached the Ross Ice Shelf where he wintered at a latitude of 79 degrees. In October, at the start of the Antarctic spring, he set off with four companions, five sledges, 70 dogs and provisions for four months. Crossing the Ross Ice Shelf, the party advanced into the interior of the continent, covering about 20 miles each day. To do so it had to pass over the mountains of the Queen Maud Range at heights of 13,000 feet and later the polar plateau at over 11,000 feet. The five men were the first to reach the South Pole. Considering the terrible weather they encountered they accomplished their journey with incredible speed—a total of 97 days outward and return. Born in Norway in 1872, Amundsen dedicated his life to exploration. On June 18, 1928, he left Tromso by air to help in the search for the missing Arctic expedition of the Italian general Nobile. From this flight Roald Amundsen never returned.

DISCOVERY & EXPLORATION *(Cont'd)*

to reach them the next summer and two men from the ship set off by sledge to try to contact the expedition. The *Antarctic* was finally crushed in the ice, the crew taking refuge on Paulet Island.

The two-man sledging party finally reached the main party on Snow Hill Island in October, 1903, after a winter spent feeding on penguins, in a primitive stone hut. Meanwhile the lack of news led Argentina to send out a naval vessel, the *Uruguay,* to search for the expedition, which was located on November 8. A few hours later the first survivors from Paulet Island reached the base at Snow Hill, just before the relief ship was due to sail. The whole expedition was then safely extricated, thanks to this extraordinary good fortune and the successful search under Captain Irizar of the Argentinian Navy.

Scott's *Discovery* expedition of 1901-04 was the chief British National Expedition of this period. The ship remained frozen into the ice of McMurdo Sound for two years while Scott led the first parties to penetrate any considerable distance into the interior of the continent. He first sledged south over the Ross Ice Shelf to 77° 59' S, and then, the following summer, through the mountains of Victoria Land on a journey to the west. He found only a high, featureless plateau of ice beyond the mountains.

The fourth notable expedition of this time, the Scottish National Antarctic Expedition of 1902-04, under W. S. Bruce, tried to penetrate the ice of the Weddell Sea and discovered Coats Land on the eastern side of the Sea. It was a forbidding, ice-covered land bounded by high cliffs which prevented a landing.

The expedition started a meteorological and magnetic observatory on Laurie Island in the South Orkneys, and since they were unable to ensure its continued support from Scottish sources, they handed it over to Argentina at the end of the expedition. The observatory has since been maintained continuously by Argentina, and provides the longest run of meteorological records now available from such a high southern latitude.

Meanwhile, the French Antarctic Expedition of 1903-05 under J. B. Charcot, was working on the western side of the Antarctic peninsula, and from 1908-10 Charcot continued investigations in the same area.

Edward Shackleton, the most outstanding leader of men in the Antarctic during the twentieth century, led the British Antarctic Expedition of 1907-09. After wintering at Cape Royds in McMurdo Sound, he followed his earlier path with Scott over the Ross Ice Shelf, using ponies to draw the sledges over the flat surface. Shackleton discovered the Beardmore Glacier, which he ascended to the polar plateau by manhauling, and pressed on to within 97 miles of the south pole. At this point, so close to success, he estimated that he could go no further if his party was to return alive, so he turned around and was just able to get back to McMurdo Sound.

His judgment in returning has never been questioned, since most leaders would have turned back sooner. Instead, he was widely acclaimed for the biggest advance of any expedition towards either of the poles. His northern sledging party under Professor Edgeworth David reached the South Magnetic Pole for the first time while Shackleton was making his dash.

The next five years not only saw the struggle to reach the pole, and Shackleton's attempt to cross the continent, but also ushered in an era of increasing scientific study. It is little wonder after Shackleton's success that Scott's *Terra Nova* expedition of 1910-13 should choose ponies as the main form of transport in preference to dogs, which had not performed well on the *Discovery* expedition.

Amundsen, on the other hand, handled dogs superbly, and after wintering in the *Fram* in 1911 at the Bay of Whales on the far side of the Ross Ice Shelf from Scott, he was the first to reach the pole by a month.

The heroism of Scott's struggle to reach the pole, only to find the Norwegian flag there, and his ill luck with weather on the way back which caused the deaths of the

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Fifty years ago

FIRST MEN REACH THE SOUTH POLE

Photos courtesy Scott Police Research Institute.

SCOTT. On January 17, 1912, Scott reached the Pole only to find the Norwegian flag (above) which had been raised there by Amundsen nearly one month earlier. Scott did not follow the same route to the South Pole as Amundsen, and he took motor-sledges and ponies with him instead of dogs. But the sledges were soon out of action and the ponies had to be destroyed on the outward journey which was made in fierce snow blizzards and lasted no less than 79 days. It is easy to imagine the despondency and disappointment of Scott and his companions when they realized they had lost the race to the Pole. Ill luck dogged them on their return journey when the same blinding blizzards lashed them, for 57 days, bringing their venture to a tragic end. Evans and Oates were the first to die. Scott, Bowers and Wilson still steadfastly guarded their notes, their photographs and the geological specimens which proved that a sub-tropical climate once existed in Antarctica. They perished of cold and hunger less than a dozen miles from a depot of food and fuel. In the diary, which he kept until his strength ebbed away, Scott wrote: "I do not regret this journey... We have been willing to give our lives for this enterprise... Take comfort in that I die in peace with the world and myself and am not afraid."

At the end of 1961 an Anglo-Norwegian ceremony took place at the South Pole Amundsen-Scott station of the United States. To mark the fiftieth anniversary of the conquest of the South Pole a commemorative plaque was placed there (below) to honour the first two expeditions to reach the Pole. The plaque bears the names of Roald Amundsen and his companions—O. Bjaaland, H. Hanssen, E. Hassel and O. Wisting—and those of Robert Scott and his party—E.A. Wilson, L.E. Oates, H.R. Bowers and E. Evans. It was placed in position by Tore Gjelsvik (standing behind it, centre) of the Norwegian Polar Institute and, Gordon de Q. Robin (author of this article, standing left of the plaque). Left, photo taken on December 14, 1911 at the South Pole showing Olav Bjaaland and Oscar Wisting making meteorological observations. The photo was autographed by Bjaaland in 1960 shortly before his death.

Photos © N.T.B. Oslo

From dog sledges to sno-cats

members of the party within 11 miles of ample food are well known. The scientific investigations of the expedition set standards which many have tried to follow but few have attained. Amundsen's example with dogs has been widely followed, and at present many still consider them the safest form of transport for detailed study of difficult mountain regions of the Antarctic.

At the same time as Amundsen and Scott were establishing their bases, Filchner's German South Polar Expedition of 1910-12 succeeded in reaching Vahsel Bay at 78° S, the southern-most point of the Weddell Sea, but was forced to winter on the expedition ship in the drifting pack. Unlike Shackleton's, four years later, Filchner's ship survived.

Shackleton, with the British Imperial Trans-Antarctic Expedition of 1914-16, attempted to reach Vahsel Bay to establish a wintering base from which to cross the continent, but he also was forced to winter in the pack ice. After his ship *Endurance* sank, his achievements in extricating his party without loss of life were an epic. The work of Bruce, Shackleton and Filchner at this period resulted in the mapping of most of the eastern side of the Weddell Sea.

Japan entered Antarctic exploration for the first time with its South Polar Expedition of 1911-12 under Shirase, while the Australian Antarctic Expedition of 1911-14 under Mawson, who had accompanied David to the south magnetic pole, mounted two bases and mapped extensive coastal areas to the south of Australia.

This expedition was the first to maintain radio communications with the outside world. The long radio wave lengths used at that time necessitated an intermediate station on Macquarie Island to relay messages to Australia, and the project was a success. The extreme winds experienced at the expedition's main base, Cape Denison, deserve mention, as they poured down off the slopes from the inland ice and averaged some 50 m.p.h. during the whole year.

ALTHOUGH the first years of this century have been called the heroic era of Antarctic exploration, they foreshadowed the mechanical era which followed. Shackleton in 1907-09 took the first mechanical transport to Antarctica, an Arrol-Johnson motor car which performed usefully over the sea ice of McMurdo Sound. Scott took three tracklaying vehicles south, two of which helped drag stores over the Ross Ice Shelf. Mawson's expedition of 1911 might well have led the way in polar flying but for an accident to the aeroplane in Adelaide which destroyed the wings. They, nevertheless, took the remainder of the plane south and used it as a propellor-driven vehicle for some short runs. None of these experiments, however, proved of major benefit at the time.

The effectiveness of mechanical transport in Antarctic exploration, both on the surface and in the air, was shown between the wars. The main credit for this must go to the United States expeditions under Byrd and Ellsworth, although British and Norwegian expeditions also developed the technique. The first flight in Antarctica was made by the British and United States Wilkins-Hearst Antarctic Expedition. Wilkins, in spite of bad weather, flew to 71° 20' S down the Antarctic peninsula, which he concluded was not continuous, but consisted of a series of islands.

This was disproved by the British Graham Land Expedition of 1934-37, who used a light aircraft and dog sledging methods to explore chiefly the west coast, where they discovered King George V Sound, which was subsequently shown by Ronne in 1941 to separate Alexander (Is) Land from the main mass of Antarctica. Charcot (Is) Land was also considered to be an island as a result of flights by Wilkins' second (British) expedition.

The three United States expeditions led by Byrd in 1928-30, 1933-35 and 1939-41 all made extensive use of aircraft and mechanical vehicles, although some dog transport was also used, particularly on a long journey led by Gould during the first expedition. Although he made the first flight over the South Pole in 1929, Byrd concentrated mainly on exploration of the sector south of the Pacific Ocean which had defeated direct approaches from the sea. He showed that there was no connexion between the ice shelves at the head of the Ross and Weddell Seas, and mapped new mountain ranges and sections of coastline. His second expedition was the first to try seismic shooting techniques to measure ice thicknesses in Antarctica.

Another United States citizen, Lincoln Ellsworth, made several notable flights over the continent, including one crossing from the peninsula to the Ross Sea. Further mapping was accomplished by the Norwegian whaling fleet of Lars Christensen, by the British-Australian-New Zealand Antarctic Expedition of 1929-31, and the German New-Schabenland expeditions. The British Discovery Investigations carried out extensive oceanographic studies of Antarctic and southern seas between the wars but the war put a temporary stop to exploration by European countries in 1939 and by the United States in 1941.

THE remaining gaps in the Antarctic coastline were filled in, largely by aerial survey, during the five years from 1945-50. The United States Navy operation "Highjump," a private U.S., expedition under Ronne and the British Falkland Islands Dependencies Survey all helped to fill major gaps. It has therefore taken around 130 years to discover the main features of the Antarctic coast and to open the way for more detailed studies. Such investigations in the region of the peninsula have now continued for the past fifteen years, where the topographical mapping by the British, hydrographic surveys by Argentina and some Chilean work warrant special mention.

Early in 1950 two expeditions landed on the main block of "East" Antarctica, the French near 140° E and a combined Norwegian-British-Swedish expedition at 11° W. Their use of modern technique to study the upper atmosphere over the continent and their observations of the thickness, nourishment and temperature of the ice sheet showed the need for a comprehensive attack on the scientific problems of the continent.

The subsequent planning of the International Geophysical Year opened the way for a major international effort, of which the achievements are too numerous to mention in a short article such as this. Overland parties have covered some 9,300 miles, generally sounding the ice cover along their routes, and many miles of aerial reconnaissance and mapping have now given us an idea of the nature of four-fifths of the interior of the continent, and of the principal mountain ranges. The huge dome of ice of "East" Antarctica, rising to some 13,000 feet above sea level, contrasts with the two great seas and ice shelves located in the western hemisphere.

Between these shelves the few mountains exposed could better be called islands than continents since great thicknesses of ice rest on a rock floor below the present sea level over wide areas. In fact, should the ice sheet be removed, it is likely that the great Antarctic peninsula would be a large island separated from continental East Antarctica.

It is clear that the discovery and exploration of the Antarctic continent cannot be credited to any one nation. It is the result of the work of very many expeditions—a truly international achievement to the credit of a few generations between the eighteenth and twentieth centuries.

GORDON DE Q. ROBIN *is director of the Scott Polar Research Institute in Cambridge, England, and secretary of the Scientific Committee for Antarctic Research of the International Council of Scientific Unions (ICSU). He was a member of the Norwegian-British-Swedish Antarctic Expedition* (1949-1951).

LIVING AT 70° C. BELOW ZERO

by Paul A. Siple

This scientist participating in America's "Operation Deep Freeze" in Antarctica, wears full face mask and dark goggles as protection against wind, ice and snow. In Antarctic temperatures a nose can freeze in seconds. The U.S.A. established five major Antarctic stations during the IGY, four of which are still in operation.
USIS. US Navy

Most persons who view Antarctica only from a great distance, recoil at the thought of personally visiting the region, sure that they could not stand the torture of intense cold. Even those who live in parts of the world where snow is unknown have sensed the unpleasant sensations and pain associated with unseasonably cool periods. If I feel so miserable on a chilly

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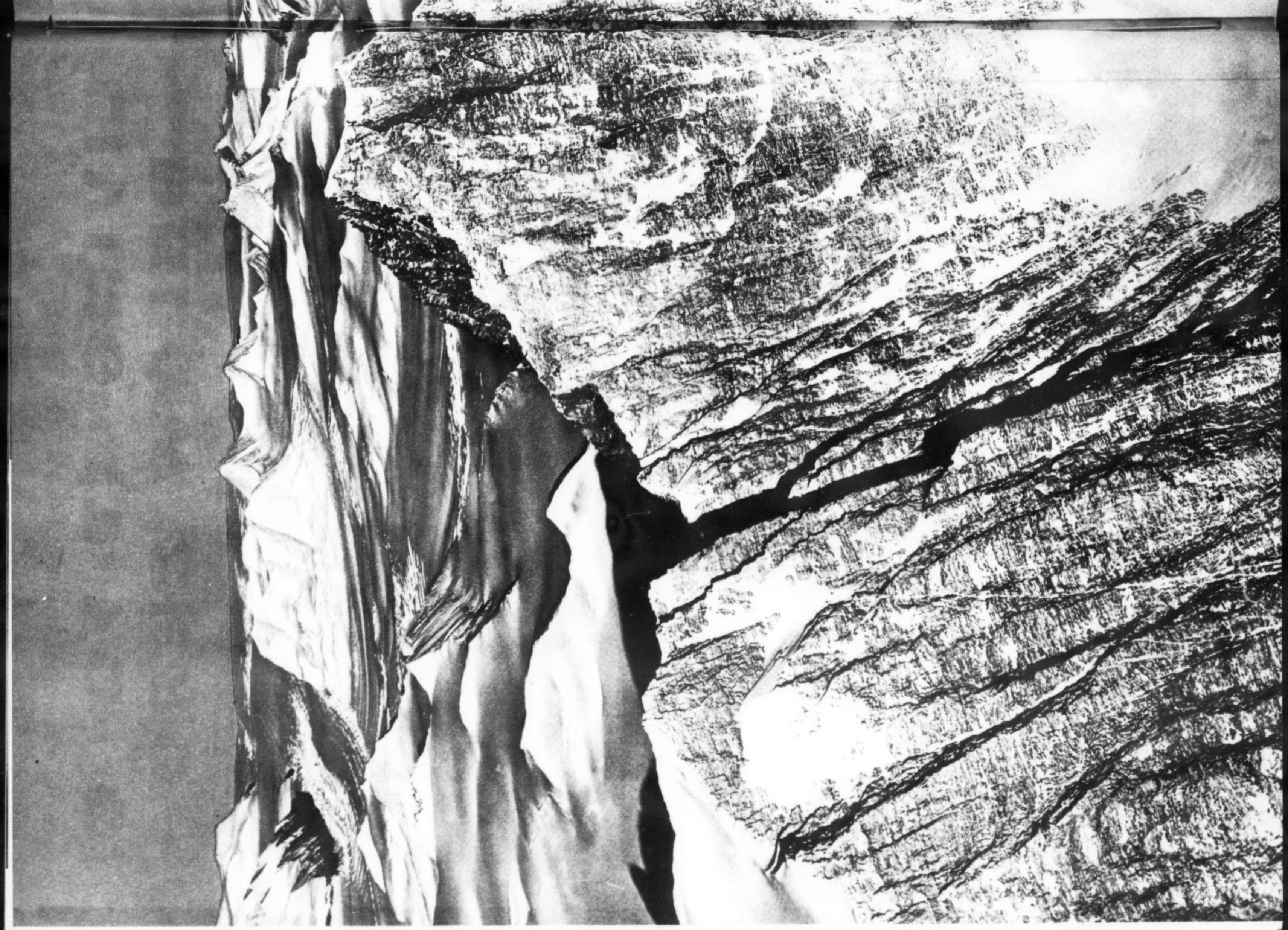
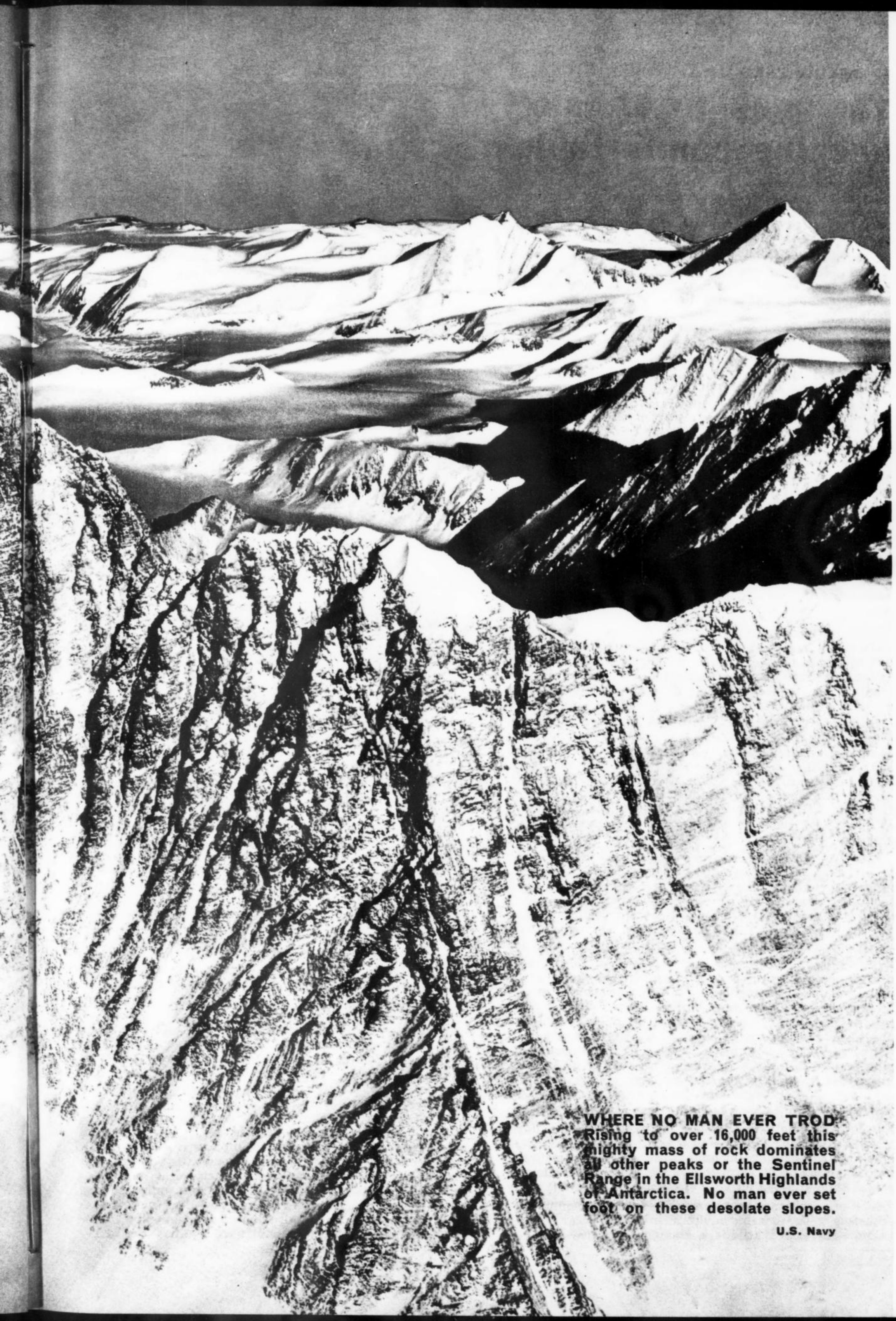




WHERE NO MAN EVER TROD
Rising to over 16,000 feet this mighty mass of rock dominates all other peaks or the Sentinel Range in the Ellsworth Highlands of Antarctica. No man ever set foot on these desolate slopes.

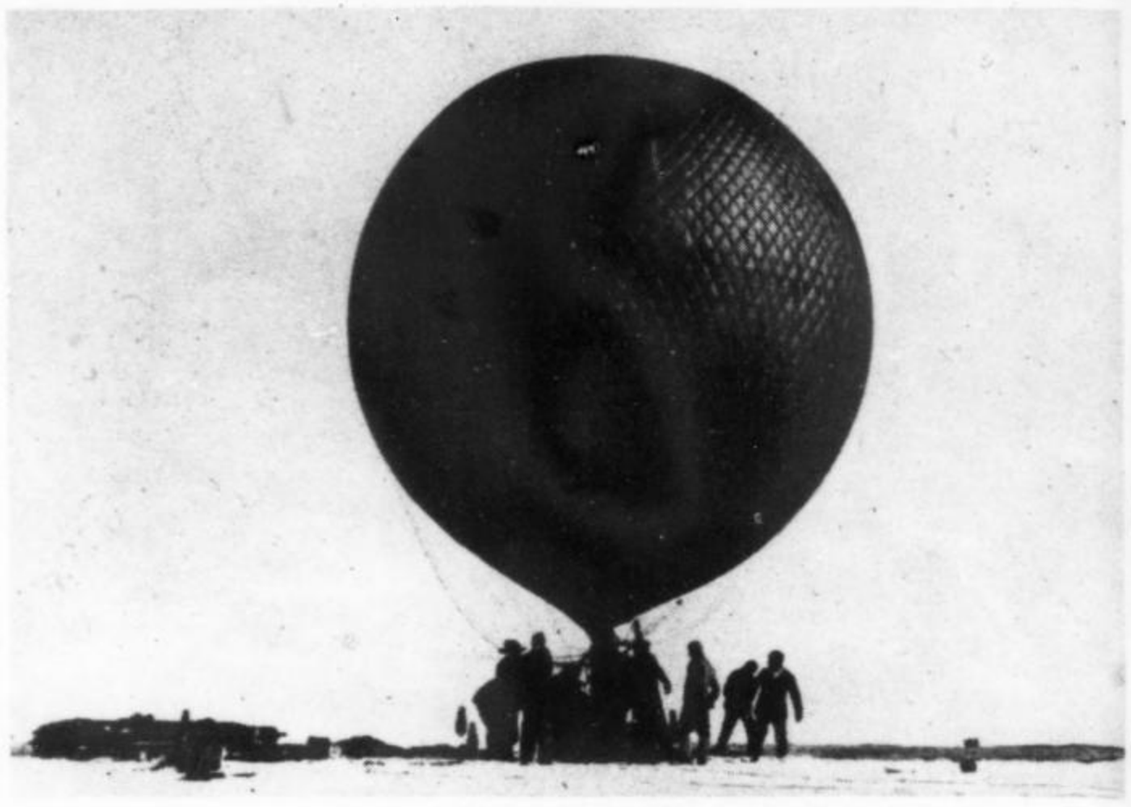
U.S. Navy

The secret of keeping comfortable

day, they reason, how could I ever stand temperatures of minus ten, let alone minus seventy.

Fortunately for the explorers of Antarctica, who of course need to learn the technology and use of protective clothing and shelter, nature too helps to make the cold more tolerable. First of all, the body itself adjusts by an acclimatization process to conserve its heat better and tolerate the sensation of cold more comfortably. This adjustment alone is roughly worth the equivalent of at least one layer of clothing. Secondly, cold climate visitors are relieved to discover that intensity of pain sensation does not increase proportionately to the degree of coldness.

Pain due to cold is nature's way of warning the conscious mind that unless something is done to correct the situation, we may get into trouble. It is like a fire alarm which is just as loud and noisy for a little fire as it is for a disastrous conflagration. Therefore, anyone exposed to an unseasonably chilly day in the temperature or even sub-tropic zone when inadequately clothed or sheltered, may suffer just as much as one exposed to extremely low temperatures in polar regions.



Photos courtesy of Scott Polar Research Institute

FIRST BALLOON. Members of Scott's "Discovery" expedition (1901-1904) prepare to send aloft a captive balloon with an observer in the basket. This method was also used by the German expedition under Drygalski but was later abandoned as too risky an operation.

FIRST AEROPLANE in the Antarctic was brought by the Australian expedition under Douglas Mawson (1911). After the wings were destroyed in an accident, it was used as a propellor-driven vehicle. Wooden skis protected the propellor from danger of nosing over.

LIVING and working in Antarctica is not at all impossible for anyone who has the desire to learn how. In fact, it can be enjoyable much of the time. But there are many things to master and sometimes the difficulties seem insurmountable to the novice. All his reading and concepts seem different from what he actually encounters.

Getting comfortable is perhaps the first problem—learning not to get overheated in exercise. Perspiration can cause accumulation of a kilo or two of water in one's clothing which later evaporates to chill the wearer or turns into ice and makes him still more uncomfortable. An old polar hand working next to the newcomer, just as hard, ventilates or controls sweating at the right moments and has dry clothing and no excessive after-chilling.

Every normal task outdoors seems to take much longer to perform. Walking is slower, gloved and stiff fingers hinder dexterity, bulky clothing gets in the way, small tools laid down beside a worker disappear like magic if there is enough breeze blowing to shift grains of snow about. Boxes, barrels, and whole caches of material can disappear from sight in one blizzard and can be lost for all time if not marked with poles.

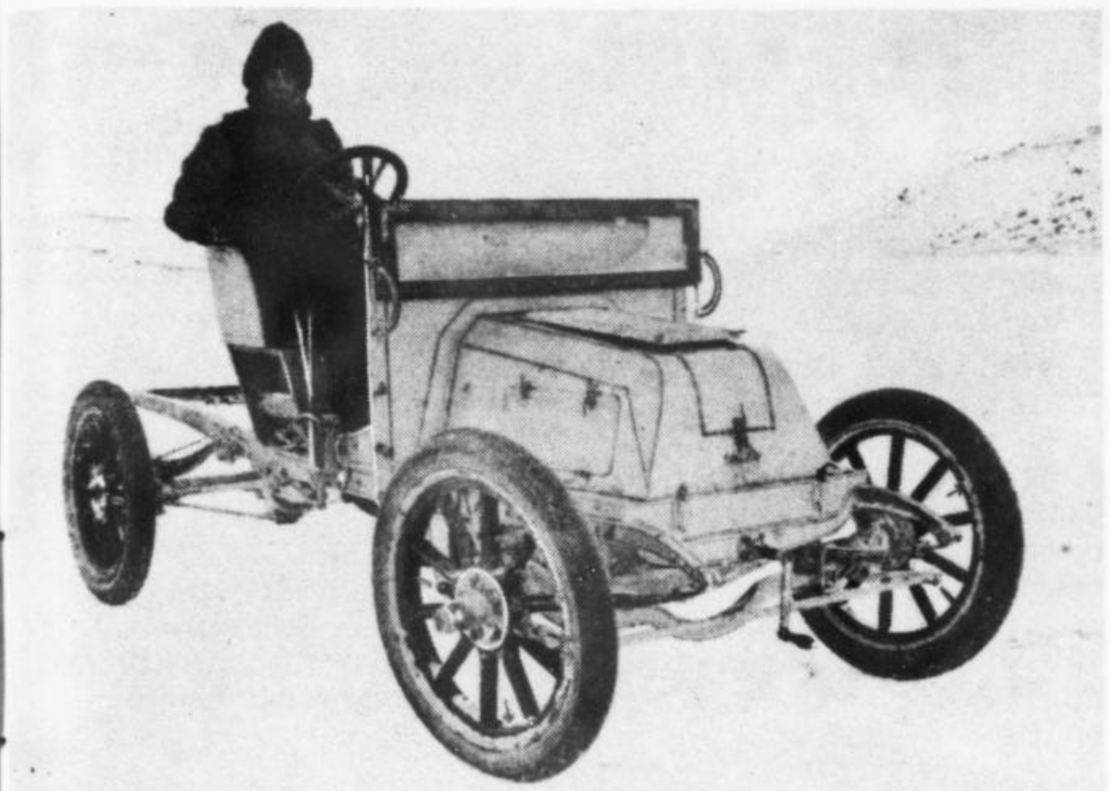
Visibility is hampered by fog and drifting snow or by white-outs—a phenomenon occurring when the whiteness of cloud cover and the snow surface blend into a shadowless world. Distance becomes hard to judge when there are no familiar landmarks, such as trees or houses on the horizon. Wind is not only a furious force, at times whipping up and filling the air with snow, but the breeze also intensifies the feeling of cold to three times that of a calm day. Sun and wind burn the face and dryness cracks the lips.

Still, after one gets adjusted, the beautiful calm days, sunsets that last for days, halos, Aurora australis, the vast quietness, and the quaint animal life, add a charm found nowhere else. Many learn to love life in the Antarctic and return time and again.

Man can look back on a long process of overcoming and adjusting to the extreme environment of the polar regions. Eskimos developed adequate, though primitive solutions for clothing and shelter against cold. Early polar travelers adopted these principles and survived. Fur clothing, snow or sod huts and dog teams, however, are no longer compatible with the life and activities of modern Antarctic exploration.

Roald Amundsen and Robert Peary owed their success in being first to reach the earth's poles to adopting Eskimo clothing, protection, and travel methods. Shackleton and Scott met with less success in their efforts to attain the South Pole because they tried less well-proven techniques. On the other hand, though Scott and his men lost their lives and Shackleton failed to reach the Pole by less than two degrees of latitude, their parties were equipped to make better scientific observations.

As a member of Richard Byrd's various Antarctic expeditions I had the personal privilege of experiencing first hand the transition of polar technology from the primitive to modern. In 1928, some 17 years after Amundsen's and Scott's South Pole ventures, we arrived at the Bay of Whales, Amundsen's old base site. We not only had dog teams aboard our sailing vessel, but also three new advances in polar technology—airplanes, aerial mapping cameras, and radios, offering a safeguard against loss of life



FIRST MOTOR CAR to be used in Antarctica was this Arrol-Johnson 12-15 H.P. which Shackleton took with him on his 1907-09 expedition in the "Nimrod". It proved to be very useful when running on hard sea ice, but was unable to travel across soft surfaces.

Tass

FIRST VEHICLES used were sledge and dog teams. Many specialists still consider them the safest form of transport for detailed study of difficult mountain terrain. Sometimes they are equipped with a bicycle wheel and mileometer for clocking distance covered.

on the trail. Radios could have saved the lives of Scott and his men who died of cold and hunger only a few miles from help. Primitively, however, we still depended upon fur clothing, lived in congested quarters to conserve coal, and our food included use of whale, seal, and penguin meat to supplement canned, salted and dry rations.

By 1934 most of our material was transported by reinforced metal freight vessels, and tractors were available to augment dog-team transportation. Six years later our housing was far more comfortable by comparison and less congested. Fur clothing was retained for emergency trail and flight use only. Tractors and airplanes supported ground parties so that dog teams were no longer heavily laden. Food included frozen meats, vegetables and fruits. Amateur radio channels permitted frequent voice contacts with fri nds and loved ones. Electric lighting replaced candles and fuel oil lamps. Labour expended for living began to lighten and men were free to carry on research between stints of shoveling snow which had to be melted for water, little of which was available for baths and laundry. Toilet facilities were unheated.

After World War II powerful ice-breaking vessels and

Polar town-planning

fast ice-worthy freighters became available. New scientific curiosity of world-wide geophysical phenomena pointed to the polar regions as keys to important new knowledge. The scientific demand for this knowledge rose to its height at the outset of the International Geophysical Year (1957-1958). Not only did 12 of the 66 cooperating nations decide to establish or utilize some 50 stations in high southern latitudes, but bold concepts arose to establish observation stations inland, and crisscross the continent by traverses to study past climate conditions by seismic measurements of snow accumulation and total thickness of the ice.

The urgency to learn more about earth phenomena transcended fears of the icy unknown which in the past had claimed the lives of men pitted against its frigid elements. In 1956 France, the United Kingdom, the Soviet Union, and the United States planned inland stations in addition to their coastal quarters at least three of which were later to house in excess of 100 men over winters.

Although the science programmes were internationally closely correlated, logistics were largely the responsibility of the individual nations. Some countries, such as Belgium, Japan, and New Zealand and South Africa, had not had recent experience in modern polar operations and had to make a fresh start; Argentina, Chile, and Great Britain, on the other hand, converted their operating bases to IGY use. France had been established in Antarctica since 1950, Norway, and the United States had more recent bases, and the U.S.S.R. had developed its competence in the high Arctic. Exchange of technology was freely dispensed to those who needed help, and communication, rescue plans and logistic aid, where possible, were jointly planned.

Each nation had its own tastes in housing, clothing, food, and transportation so that the stations had their own individual character despite similarities of purpose. Some stations were built on solid, snow-free land and others on kilometre-thick snow fields with no bare rock in sight for hundreds of miles in any direction.

Building houses on rock or rubble permitted more conventional construction techniques; foundation excavation, however, was difficult. Cold and lack of sand inhibited the use of concrete and a short summer construction period demanded the use of impromptu techniques rather than the best. Sewage and waste disposal was difficult, if immediate access to the sea was not available. Ponds or snow patches for water supply were at times located at considerable distance from the houses. Cables were essential to anchor the houses against heavy wind and at least at Hallett Station, the joint New Zealand-United States Station, penguins from an adjacent rookery had to be removed and fenced out to permit flat space for the camp.

Placing a station on deep snow requires different techniques. The foundation must be compacted or excavated, insulated and blocked to prevent differential settling. At some stations a deep pit is dug in which the house is erected. Then snow which fills in around the building provides insulation necessitating less heating than is required for houses built on open ground, fully exposed to excessive wind-chill.

Another technique not requiring excavation is to build the houses on the surface and simply let snow drifts accumulate around the buildings until they are covered up to the eaves. In this latter construction method stacks of stores are placed around the houses, covered by chicken wire and burlap or dunnage and tarpaulins, to form passages or framed tunnels. Houses buried from the start

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Fire one of greatest hazards

Australian official photograph

AUSTRALIAN EXPLORER demonstrates latest clothes style in Antarctica.

are usually connected by snow tunnels dug between buildings. Excavated snow rooms and snow block storage shelters save on materials which must be brought in. Sewage and refuse are usually dumped directly into pits. Snow for water supply is always close at hand in areas upwind away from station contamination. Ventilation for buried camps becomes a problem at times. Added floor vents are required as well as ventilator outlets. Carbon monoxide created by snow covered flues or icing of condensed moisture is often a hazad.

Fires at isolated drifted-over stations is perhaps the greatest hazard to men in polar camps. Fires seem to occur on the coldest or windiest days. Passages can fill with smoke and fighting tre in submerged snow is next to imposible. Notonly is fire disastrous to men and equipment inside the building, but the fire fighters during a nocturnal blizzard are also exposed to danger decause often in their haste they rush to the emergency with insufficient time to clothe themselves properly. The most disastrous Antarctic fires occured in the 1960-1961 season at the Soviet Mirny Station where eight lives were lost and at the American McMurdo Station with an estimated property loss of about two-hundred thousand dollars.

Some stations are built from lumber and materials similar to normal frame houses, but much time is saved by having houses prefabricated. A large house can be assembled in a single work day, if the panels arrive undamaged and no parts are lost in the thousands of miles of transit and frequent handling. Gable-roof houses shed melt-water better, but drifts build higher than on flat-roofed structures. In deep snow-field areas, drifts engulf the entire camp to the height of the largest structure. Thin towers or observation booths placed above the surface on legs, permit the wind to blow past without dumping its load of snow.

Inland stations were handled in different ways. The British built South Ice Station, Lat. 82° S., Long. 29° W., in a hole by constructing a sturdy building for three men of timbers taken in by tractor. France's Station Charcot, Lat. 69° 30' S., Long. 140° E., was a small, arched roof bungalow built on sleds and dragged to its destination by tractors. The various Soviet inland stations of Vostok I and II, Pioneerskaya, Komsomolskaya, and Sovietskaya, located at or en route to the Geomagnetic Pole and the Pole of Inaccessibility, were uniquely designed tractor quarters which could be expanded at the wintering destination and re-supplied by air.

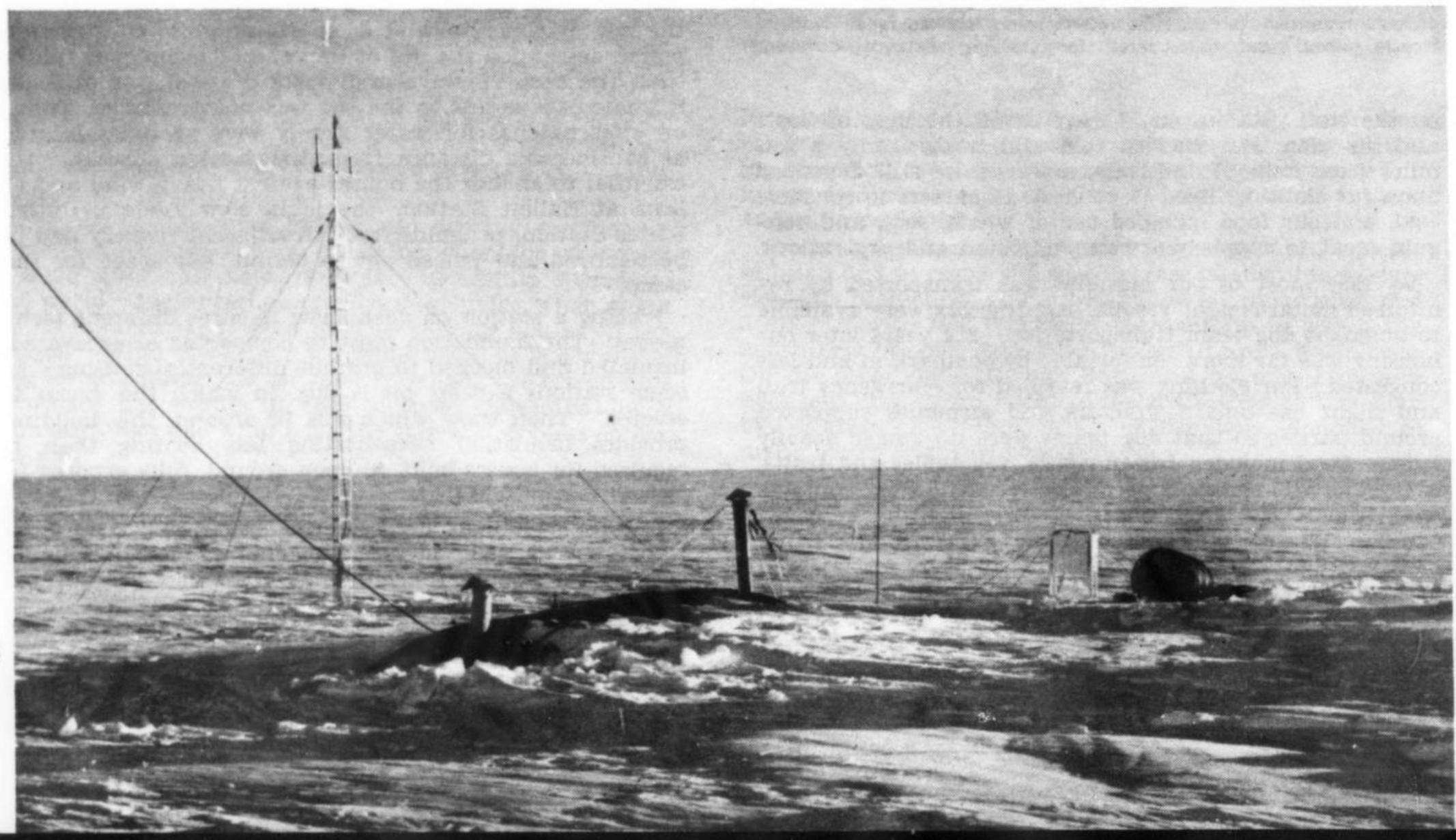
The American Byrd Station at Lat. 80° S., Long. 120° W., was the largest inland station designed for 25 men. It was originally supplied by great tractor trains and later by air. The American geographic South Pole Station, named Amundsen-Scott, where I served as the Scientific Leader during its first year of occupation, was a station for 18 men, supplied by C-124 Globemaster parachute drops and a few P2V and R4D ski-plane landings. The altitude of over 9,000 feet required jet assist to lift off the planes, even lightly loaded ones. Since 1960 C-130 turboprop aircraft land at the pole to discharge their cargo directly.

The coastal stations at some places are near or even north of the Antarctic circle so that although they have little daylight in winter, they virtually have no sunless or continuous daylight periods and the coldest temperatures in winter rarely go below -40° C. Summer time temperatures frequently rise above 0° C. Inland conditions are much colder even if not as windy.

The stations farther poleward have sunless periods in mid-winter and continuous sun in midsummer, and at the geographic pole there are six months of each. On the high, mid-continental plateaus, extreme temperature in winter drops below -75° C. and in some places perhaps down to nearly -90° C. At the South Pole the first year

BURIED TO THE CHIMNEYS in a sea of snow this Australian outpost, 50 miles from the Wilkes Antarctic base, permits scientists to live and carry out research for an extended period.

Photo R. Dingle-Antarctic Division, Australian Department of External Affairs



US Navy

SPRING CLEANING for the walls of a snow tunnel which is the main street of America's Byrd Station at an altitude of 5,000 feet in the mountains of Marie Byrd Land. Here, as in all major U. S. IGY stations, research was made in meteorology, geo-magnetism, glaciology, physics of the ionosphere and studies of the aurora.

there were 159 successive days during which the temperature never rose above -40° C. and the wind averaged over 15 knots.

Inside the quarters at most bases the temperature was maintained at a comfortable (15 to 18° C.) shirt-sleeve temperature (i.e., a wool shirt over heavy underwear). Men sleep in beds with sheets, blankets, and pillows. They have excellent libraries, warm toilets, showers, and laundry facilities, movies, and normal meals except for the absence of fresh greens. At some stations greens were grown and at Mirny a herd of pigs solved both the garbage disposal and fresh meat problem. In short, life indoors was fairly normal at all bases except for the absence of women.

ONE time at the South Pole two of our men wanted to go out and see how long they could stay in the open—it was about -72° C. with a 12 knot wind. We knew that under exposed conditions we had clocked freezing time of noses, cheeks, and ears at about 30 to 45 seconds. But they were well bundled up in several layers of clothing totaling about 12 to 13 kilogrammes including their boots and a belt of batteries next to their bodies to light a head lamp.

It was dark outside and they planned to move about. One man stayed out three hours and the other four hours. They quit not so much because it was cold, but because they were growing tired; they had already put in their day's work and were cutting into their bed time. They were cold in spots, but they suffered no frostbite or other ill effects.

There are some physiological limitations to the extreme environment of Antarctica. With fast walking or heavy work at sea level, when temperatures drop below about -50° C., men become winded and they may start to cough and spit blood. They have not frosted their lungs but have ruptured capillaries in their bronchial trachea. At high altitudes men working heavily at low temperatures despite ample food tended to lose a tenth of their body weight in a month's time. Leaving eyes unprotected from bright reflection from the snow and sky in summer time, caused painful temporary blindness.

Although there is a wide variety in clothing from station to station and sometimes an equal diversity from man to man in any single station, the basic principles are nearly the same. In summer, when temperatures range between 0° C. and -20° C., the men who are outside for considerable periods and quite active, wear surprisingly light clothing, often only a light set of loose-fitting cotton, windproof trousers and hooded jackets over wool or heavy cotton underwear. More sedentary or unacclimatized persons will wear an intermediate layer of wool trousers and wool shirt, sweater or vest.

Boots vary widely. There are oversized ski boots, or mukluks with room for heavy socks and insoles, felt boots, or the insulated boot (the invention of which I was associated with) which is a double-layer rubber boot with insulation sealed inside—a light pair of socks is all that is worn inside.

Hand gear is usually in two layers—a wool mitt with a leather or canvas protective cover. Special thin contact gloves are used by some who work with delicate instruments and heavy work gloves are generally preferred by mechanics.

Head gear ranges from the conventional wool cap and a

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NO IRONING. When laundry is hung outside in Antarctic winter it becomes as stiff as an ironing board within minutes.

US Navy

FROZEN HISTORY

Scientists from many countries are now busy studying Antarctica's ice. New methods make it possible to tell what temperatures existed when the ice was formed aeons ago. Here French Polar expedition members remove cylindrical ice samples (left and below) and measure the density of granular ice (right).

Photo Jacques Masson © Explorations polaires françaises

70° BELOW ZERO *(Cont'd)*

Vacation land of the future?

long wool cap which has a face opening to leather or fabric helmets with ear flaps. For bushy-haired active individuals a ski headband with open crown, giving ear protection, suffices until the sun goes behind a cloud or the wind rises. A supplementary windproof cloth hood, usually attached to the jacket, is pulled up over the head for added protection. Dark glasses or goggles that cut down about 75 to 95 % of the light complete the ensemble.

WINTER clothing follows the same principles, but increases in thickness or number of layers, and usually has more positive closures to keep out the wind at the neck, waist, ankles, and wrists. Head gear, boots, and mitts increase to optimum values. Some men include a felt, chamois or windproof face mask, others grow beards. No amount of clothing will keep an inactive man protected for more than an hour or two, but if his heat production is increased by activity, the same clothing will keep him warm down to —40° C. or even below —70° C.

Because of the law of diminishing returns for insulation over cylindrical shapes (i. e., the surface for losing heat increases more rapidly than insulation is gained in thickness), the approximate optimum thickness of insulation is as follows: Fingers—less than 1 cm; head, hands, and feet—2 to 3 cm; legs and arms—3 to 5 cm; torso and sleeping bags—10 to 20 cm.

Transportation across snow surfaces is now almost exclusively accomplished by tracked vehicles. Numerous countries have introduced their own versions. The American-built Sno-Cat, with tracks over four triangular pontoons where wheels would be on a normal truck, has perhaps been the most popular. These were used by Fuchs on his transcontinental trip. Hillary, on the other hand, used small Ferguson farm tractors with added belt tracks most successfully.

Heavy freighting is carried on by the largest sized tractors manufactured with sleds that can hold several thousand kilogrammes. Russian tractors at the beginning of IGY had too narrow a tread width, but with each succeeding year they came back with new designs and have developed enormous tractors with built-in living quarters that have been used over wide areas of East Antarctica. They visited the South Pole in 1959-60 and a year later the Americans delivered giant D-8 tractors overland to the Pole. The World War II American Weasel, or vehicles of a similar design, serve as light, faster transportation.

Speed of the larger tractors is usually only 3 or 4 knots, but the lighter vehicles cannot go much faster than 6 to 15 knots because of the sastrugi (drifts of snow on the surface). Crevasses, which are great cracks in the snow and ice surfaces, frequently bridged over by drifting snow, form unseen hazards to travelers. Several lives have been lost by tractors dropping into these pitfalls.

Future improvements in Antarctic living are already on the horizon. Increased air travel makes direct contacts with neighboring continents possible throughout the summer. Winter-night flights have been made. We may soon expect year around contact. Women have visited the continent and some have wintered over. An increasing percentage can be expected to make up family teams or to serve as scientists and technicians in their own right.

Use of atomic reactors to supply heat, power, and lighting, is projected for the near future. The new American Byrd Station (1961-1962) is being modeled after the U.S. Army Greenland research station Camp Century, with deep excavated trenches cut by Swiss Peter Snow Millers. Both Chile and Argentina have carried out paid tourist visits in summer and soon anyone who wishes to badly enough may visit Antarctica almost any time he prefers. Commercial flights and even tourist hotels have been seriously discussed.

PAUL A. SIPLE, *U. S. explorer, geographer and author, was the youngest member of the first Antarctic expedition of Admiral Richard Byrd* (1928-30) *having been chosen from among* 600,000 *American boy scouts. He has since taken part in many Antarctic expeditions and was the scientific leader of the U.S. IGY Amundsen-Scott South Pole Station in* 1956-57. *He is the author of* 90 Degrees South (*Putnam, New York*).

OF SUNSPOTS, MAGNETIC RINGS AND 'POLAR LIGHTS'

by Alan F. Moore

ANTARCTIC research has only recently developed because the lack of overland routes makes it expensive and hazardous even to travel there. In the First (1882-83) and Second (1932-33) Polar Years very few stations were set up on the continent and no overall picture, even of Antarctic weather, emerged from these and subsequent pioneer studies.

As the International Geophysical Year (1957-58) was concerned with weather, radio, oceans on a global scale, a special effort had to be made for the Antarctic region and twelve nations set up more than 60 stations on the ice-covered continent. Much of this work is now being continued on a permanent basis.

Recently, greater use of aircraft and mechanical vehicles has given us more accurate Antarctic maps, but a million square kilometres of the continent have not yet been seen, even from the air.

The continent is covered by 20 million cu. kms. of ice, and its weight has depressed and deformed the original land surface beneath. Norwegian, U.S., Soviet and Belgian parties echo-sounding with small explosive charges (seismic shooting) have shown that a layer of ice (shelf ice) lies beyond the true coast of Antarctica and is grounded at others, whilst inland the rock surface below the ice resembles fjords.

American geophysicists have shown that the coastal mountains of Marie Byrd Land—3,500 m. high—are the tops of a series of offshore islands separated from East Antarctica by a 500 km. wide channel filled with ice. This channel reaches depths of 2,500 m. below sea level in places and joins the Ross and Bellingshausen Seas, but further work is needed to decide if there is a minor branch of it linking up with the Weddell Sea.

The rocks of East Antarctica, the older region, are related to those of South Africa and India, but the different ones in West Antarctica are similar to those in the Andes of South America. This is further evidence that Antarctica may be at least two major land areas covered by a single ice sheet.

Measurement of the depth of the Antarctic rock surface gives the ice thickness and so the volume of water locked up as ice can be calculated. Studies of the Antarctic rocks reveal that 160 million years ago they were in a sub-tropical climate. If these conditions ever returned then the ice would melt and the global sea level might rise as much as 65 metres, as already indicated earlier in this issue. In the process of melting a great weight would be removed from the rocks and they would rise.

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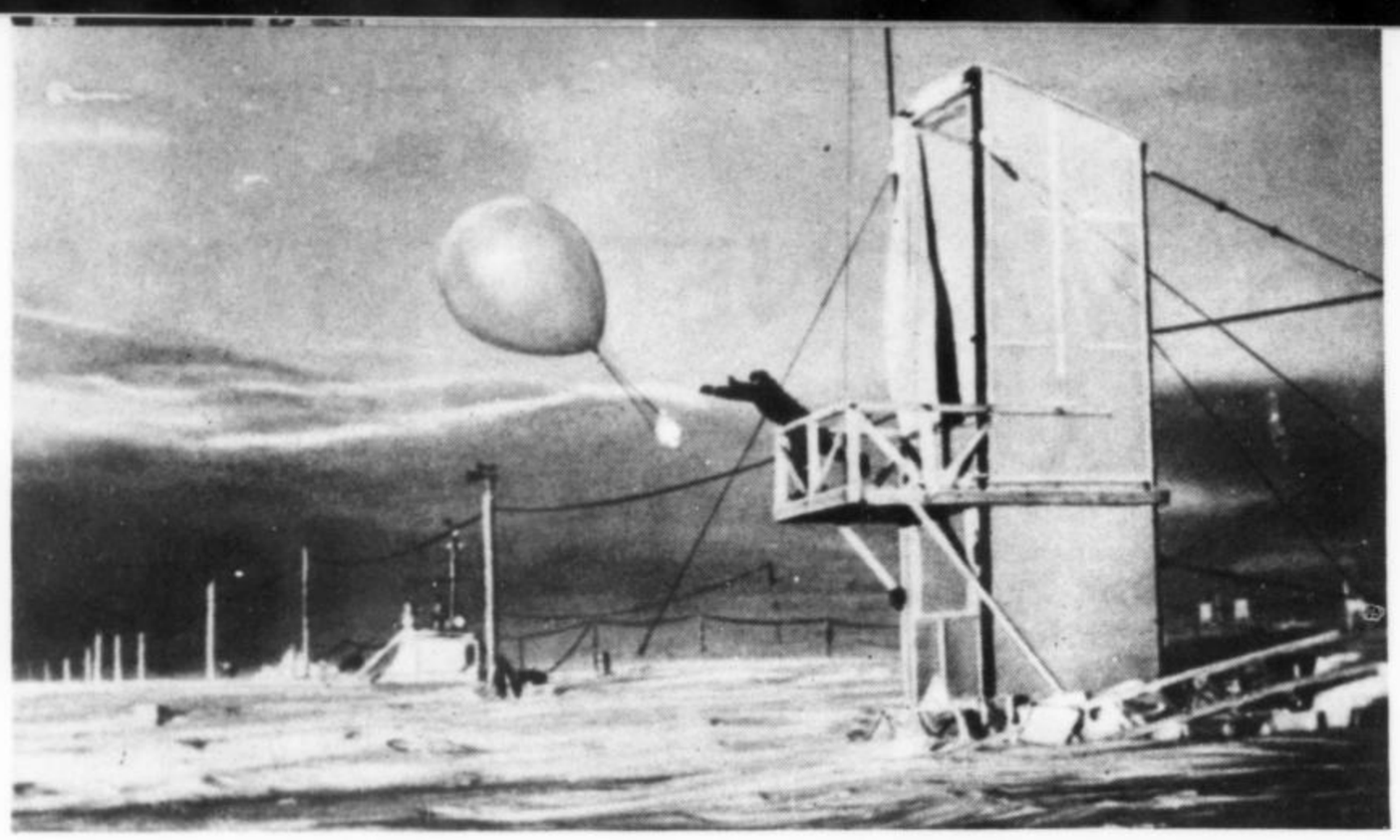
ALAN F. MOORE, *former lecturer in Geophysics at Imperial College, London, was largely responsible for the organization of the Royal Society Antarctic Expedition to Halley Bay during the IGY. He is now on the administrative staff of the Royal Society, Great Britain.*

TAKING THE WEATHER'S PULSE. Battery of weather anemometers—for measuring wind force—are here being calibrated at Little America station before installation on towers. During the IGY, a network of weather stations covered Antarctica for the first time and their reports were sent several times daily to the Weather Central at Little America. Here, an international team of meteorologists worked together to produce continental weather charts and forecasts. At one Soviet base a strange phenomenon was seen in July 1959: a blizzard of reddish snow.

US Navy



SOUTHERN LIGHTS, immense luminous rays, arcs and curtains in the heavens (right) flash and glow in the depth of the polar night. These aurora are caused by the concentrations of electrically-charged particles shot from the sun's surface into two rings—the auroral zones—around the earth's two magnetic poles.

Jacques Masson © Explorations polaires françaises

Official Soviet photo

EARS 12 MILES HIGH. A radio-sonde balloon (left) is launched from the Soviet Mirny Station. Such balloons can make records of atmospheric conditions up to 12 miles in height and report back their findings by radio.

Aurorae of different colours and shapes

The map of Antarctica might then look very different. (See page 7.) Much more evidence is needed before we can decide if the ice sheet is at present growing or decaying, and all the information must be continually exchanged in order to do this.

The ships which relieve the Antarctic bases at the turn of each year visit small islands on the way and are used to investigate ocean depth, water circulation and fish of all kinds. Continuous surveys can be made, such as the Japanese radio measurements between Tokyo and Showa Base. British scientists in late 1960 towed an instrument behind a ship from South America to Graham Land and made a magnetic survey of a submarine mountain range—the Scotia Arc. In late 1961 they exploded small charges for echo-sounding in the same area to extend this work on the geological similarities between Graham Land and South America. All the work in the oceans around the Antarctic continent requires considerable expansion for at the moment it has a much lower priority than the land-based studies.

RECORDS from magnetic observatories founded before 1900 show a slow secular change in the Earth's magnetism, regional in character consisting of 10 or more areas of increase or decrease. Recently IGY data have revealed that one the largest regions of annual magnetic change is in the Antarctic region and magnetic observations must now be obtained from many more sites there, which will make an important contribution to the current World Magnetic Survey.

The Earth's magnetic field concentrates some of the electrically-charged atomic particles which are shot at high speeds from the sun's surface into two rings—the auroral zones—around each magnetic pole. These particles gradually increase to a maximum number about every 11 years as the sunspot maximum is reached and cause an increase in the number of nights on which aurorae or "polar lights" are observed.

The aurorae appear in different colours and shapes, e.g. rays, arcs and curtains, which change throughout the night, and every few minutes all-sky cameras can record all the shapes from horizon to horizon. Two ordinary cameras on a known base-line give data about the height of the aurora—usually 100 km to the lower edge. Analysis of the light from aurorae tells us about the kinds of air molecules there are at great heights and important work of this type has been done at French Antarctic bases.

The location of the Antarctic auroral zone was a primary object of the IGY sunspot maximum programme but new inland bases are required to obtain more data for at least one sunspot cycle before the work is completed. This southern hemisphere work could not be attempted until the IGY, and then it was found that aurorae occur in the same hours, maybe simultaneously, in both the Arctic and Antarctic zones, although not necessarily in the same form.

The observatories recording the very slow geomagnetic secular variations mentioned above also record the large and rapid ones—magnetic storms—which often accompany intense auroral displays. These variations are related to the large fluctuating electrical currents set up by the incoming solar particles and their analysis helps us to learn more about the constitution of the high atmosphere over the poles.

Long distance radio communication is made possible by layers of electrified particles—the ionosphere—in the upper atmosphere and the E layer, about 120 km (75 mi) high, and the F layer, about 350 km (220 mi) high. In middle latitudes the changing height of these layers, the maximum radio wave frequency they reflect, and the drift of irregularities in them have been measured and analysed for a decade or more, but little similar work was done in the southern hemisphere until the IGY provided a very necessary expansion.

The ionosphere can be greatly disturbed by incoming

CONT'D ON PAGE 40

Government of Japan

PARABOLA ANTENNA for radar observation of atmospheric phenomena at the Showa Antarctic base where a Japanese observation party wintered for the the fourth year in succession (1960-61).

JOURNEY INTO THE INACCESSIBLE

by Mikhaïl M. Somov

Before the International Geophysical Year began in 1957, no scientific expedition had ever wintered in the heart of the Antarctic Continent. Since then the United States, the U.S.S.R. and France have all set up research stations deep in the interior. Below we publish an account of the arduous journey across 1,300 miles to reach Antarctica's Pole of Inaccessibility — the point furthest removed from the coasts where the lowest temperatures on earth's surface have been recorded.

WELL before the International Geophysical Year began five years ago, scientific circles the world over were already engaged in heated discussions about the grandiose projects foreseen as part of this unparallelled assault on our planet.

In the sweltering summer of 1955 scientists from many lands gathered in Paris to map out the work they were soon to undertake in common on the frozen sixth continent of Antarctica. Their first step was to apportion the various tasks among the different countries participating so that the whole of the Antarctic would be systematically covered by a network of observation posts.

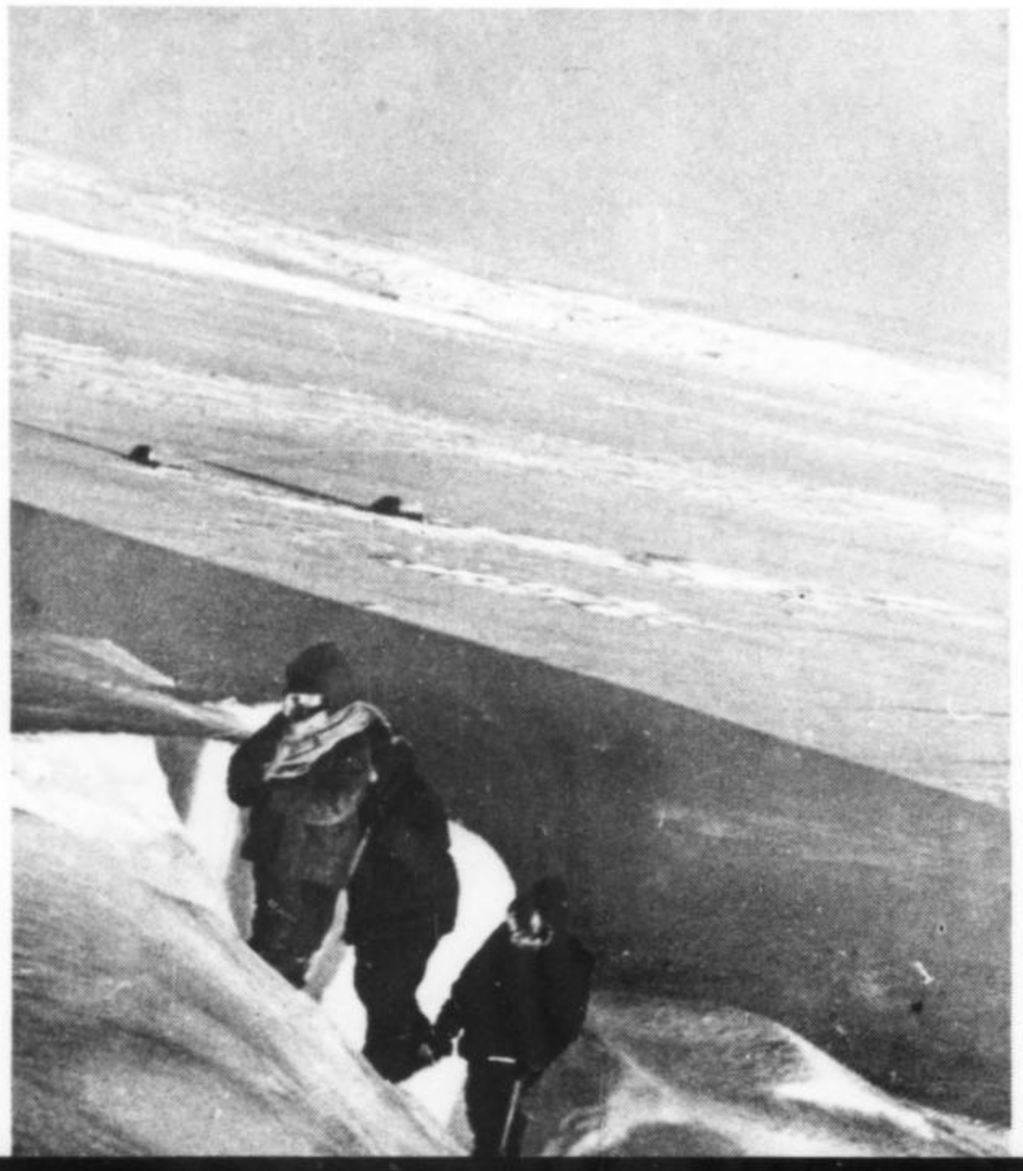
At the time, few scientific stations existed on the sixth continent and these were located only in the more accessible regions near the coast. The rest of the huge ice-covered area had virtually never been studied, except in summer when certain zones had been visited (more recently with the additional help of aircraft). No one had ventured into the heart of the continent in winter, and hence no one had yet observed the exact conditions prevailing there during the polar night.

The scientists at the Paris conference voiced their common conviction that it was imperative not only to increase the number of coastal stations but to set up a number of new stations in the interior equipped to carry out research and observations all year round. The four most characteristic points in the centre of the continent were particularly studied and it was decided to set up scientific stations in each of them.

Katojetkov-Tass

DIFFICULT CLIMB is made by three members of a Soviet Antarctic expedition up the side of a giant iceberg which has broken off from the main continental ice-mass.

Kapitza-Tass



The first was the geographic South Pole where the geographic meridians converge.

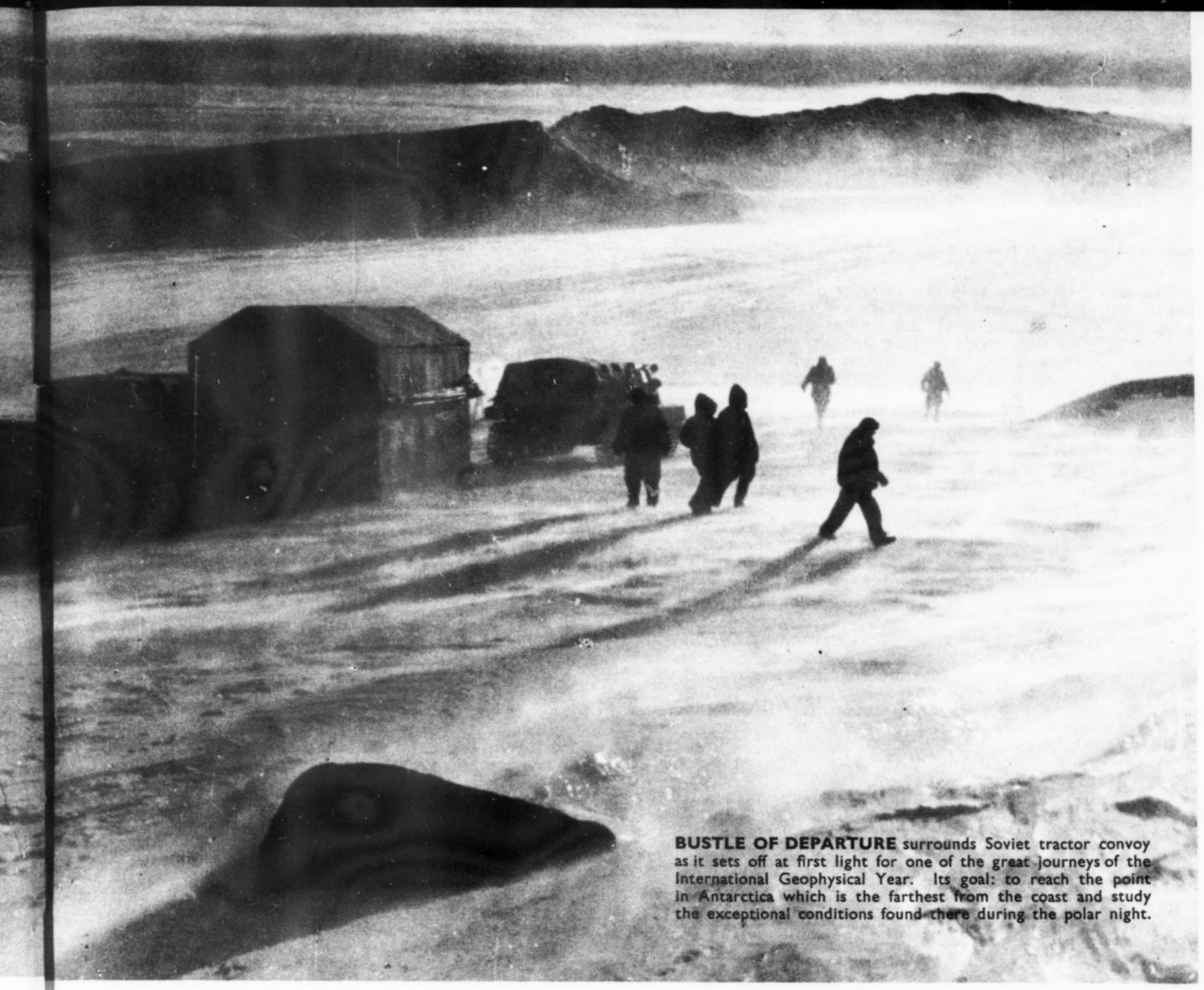
The second, the Magnetic South Pole, where the magnetic needle points and where the magnetic meridians converge.

The third was the Geo-magnetic South Pole, where the Magnetic Pole would theoretically be found if the magnetism of the globe were uniform—which it is not. The area is of particular interest to science because the intensity of geophysical phenomena occurring in the upper atmosphre varies with the distance from this spot.

The fourth was the Pole of Relative Inaccessibility, the point furthest removed from the coasts and one of the last blank spaces left on our planet. It is located in the toughest part of Antarctica to get to, where scientists felt the climate should be most markedly continental and the winter temperatures therefore exceptionally low.

None of the men attending the Paris meeting underestimated the enormous difficulties which would face the expeditions assigned to set up these four stations in the far off and as yet unknown tracts of the south polar continent.

The United States volunteered to set up a station at the geographic South Pole. France agreed to set up another in the region of the Magnetic Pole. The U.S.S.R. undertook to establish two stations, one at the Pole of Inaccessibility (about 1,300 miles from the projected Soviet



BUSTLE OF DEPARTURE surrounds Soviet tractor convoy as it sets off at first light for one of the great journeys of the International Geophysical Year. Its goal: to reach the point in Antarctica which is the farthest from the coast and study the exceptional conditions found there during the polar night.

coastal base at Mirny), the second at the Geomagnetic Pole.

To head straight for the Pole of Inaccessibility immediately on landing in Antarctica was obviously unthinkable. An assault of such difficulty, into the mos' inhospitable part of the continent, had to be conceived as an operation in several stages.

A first expedition (1955-1957) was entrusted with reconnoitring Antarctic weather conditions and investigating the possibilities of setting up stations in the interior. A second expedition (1956-1958) was to carry out a combined operation with land transport and aircraft to set up these stations, and a third (1957-1959) was to complete whatever the second expedition was prevented from doing by lack of time.

Such was the plan. And with the exception of a number of modifications found to be necessary as the operations progressed, it proved perfectly feasible. Even before the Mirny base was completed at the foot of the massive Helen Glacier, the first expedition completed several aerial reconnaissances which produced vital information concerning possible routes to the Pole of Inaccessibility and the Magnetic Pole.

The first reports to come in showed that the Mirny region was cut off from the interior to the south by an area of impassible ice crevasses. The danger zone was found to be about 30 miles wide. The crevasses themselves varied in width, ranging from a few inches to a half hundred or more yards, with depths estimated at anything from 50 feet to hundreds or even thousands of yards.

These crevasses are particularly dangerous since they are often covered by "snow bridges" piled up by frequent storms. The bridges are of varied thickness and solidity, some easily supporting the weight of a 12-ton tractor, others giving way when a man steps on them. Sometimes they collapse from their own weight.

A crevasse covered over by such a bridge is completely invisible and hard to detect even from the air. It is no exaggeration to say that crossing through such a zone of camouflaged crevasses is like walking across a minefield.

Luckily, air pilots spotted a narrow passage through this zone, and a land team was later able to mark out the route with bamboo poles. Thus the vital question as to whether land transport could be used to penetrate into the interior to set up the observation stations was now answered.

Other flights over the interior revealed that there were no landmarks on the ice cap, thus making it impossible to take bearings on the route from Mirny to the sites of the future stations.

Shortly after the completion of the main building sites at Mirny, a new effort was made to obtain information on the inland regions. A convoy of sledges drawn by two 80 h.p. diesel caterpillar tractors left Mirny on April 2, 1956 and headed south. Its mission was to reconnoitre the land and gather data on the conditions likely to confront future expeditions. The convoy covered 235 miles moving in the direction of the magnetic south pole and reached an altitude of over 9,000 feet on the snow plateau. Here they halted and subsequently became the first scientific station to be set up in the interior of the continent—the Pioneerskaya Station.

It was an arduous journey, made particularly hazardous by long projections of ice which rose from the surface to a height of a yard or more, and by the deep soft snow in which the treads of the tractors sank or skidded. The men on the sledges suffered cruelly from the rough going. Such a journey requires not only tip-top physical shape

CONT'D ON NEXT PAGE

WORLD RECORD FOR DEEP-FREEZE

and a talent for acrobatics, but dedicated enthusiasm as well.

This first expedition into the interior of the continent began in April when the Antarctic autumn is well advanced and the slopes of the ice plateau are almost ceaselessly swept by winds driving the snow before them. In such weather even the briefest halt may have catastrophic consequences. A motionless sledge is immediately covered over with snow and what may have begun as a momentary pause can turn into a forced halt lasting two or three days or even a week. Only after the storm has ended and the winds abated can the men think of freeing the sledges and moving on.

Because of the late date of departure from Mirny the men of the expedition and their work were plagued by the high winds and the extremely low temperatures which dropped well below -50° C. (-58° F) towards the end of the journey. Moreover the intense cold severely tested the solidity of their equipment, even those items made of steel.

The expedition proved that another factor seriously hampered living and working in the interior, i.e. the sharp drop in atmospheric pressure due to the high altitude of the ice cap. This not only put a strain on the men but also interfered with the functioning of their vehicles operating with internal combustion engines.

THE second Soviet Antarctic expedition, led by A.F. Trechnikov, reached Mirny at the end of 1956-early 1957. With it came ten powerful caterpillar tractors designed for travel to the heart of the continent. Preparations for the journey began at once. All the heavy equipment for setting up the Vostok station on the Geomagnetic South Pole—including housing for the men, electric generators, radio gear, a kitchen, etc.—was loaded on sledges ready for installation on arrival. At the same time the new caterpillar tractors were tested under Antarctic conditions.

On February 14 the vehicles of the second expedition left Mirny to set up the auxiliary station of Komsomolskaya. After many hardships the convoy finally reached its destination. Fuel reserves were by now exhausted and the late season made it extraordinarily difficult for aircraft to land. It was considered too dangerous for the party to winter on the spot, so after the convoy had been "weatherproofed" the entire team was brought back to Mirny by air.

On February 28, a second convoy set out to reach the site for the future Vostok station. Again, snowstorms and soft snow, temperatures of -55° C. and the rarefied atmosphere hindered progress. The convoy halted at an altitude of 10,600 feet some 400 miles from Mirny. Here a temporary inland station named Vostok I was set up and soon began its scientific investigations.

On October 8 a tractor-drawn sledge train left Mirny for the geo-magnetic pole. Huts, a generating station, a navigation post and an electric kitchen were loaded onto six tractors and the convoy with its team of 27 men under A.F. Trechnikov set off.

As it advanced it was supplied with fuel from the air, and by November 4, having passed the Pioneerskaya and Vostok I stations, it reached the point where a base had been prepared for the Komsomolskaya station during the previous autumn. From there it proceeded southeast and on December 16 it reached the vicinity of the Geomagnetic South Pole where the new Vostok station was established at an altitude of over 11,000 feet, some 875 miles from the coast.

It is in this region that a new Pole—the Pole of Cold—was discovered where the lowest deep-freeze temperature of our planet was found when a thermometer reading of -83.3° C. was recorded. The strain on research staffs of living and working in these rigorous winter conditions during the polar night can well be imagined.

Soon a third Soviet Antarctic expedition reached Mirny and prepared for the final push to reach the Pole of Inaccessibility.

On December 26, 1957, a convoy from this expedition composed of ten all-purpose tractors and 20 improved sledges left Mirny. After delivering urgently needed stores to the Vostok station and visiting the Komsomolskaya station, it set its bearings due south-easterly. The deeper it thrust into the interior the more powdery the snow became until the tractors found themselves sinking to depths of 80 inches and more.

By February 10, the convoy had travelled some 880 miles from Mirny and had reached an altitude of 11,700 feet. At this point the Sovietskaya station was established and five days later was in operation. In the meantime, the scientists and specialists at the Mirny Base had been making full use of the winter to prepare new expeditions for the spring.

ON October 24, a convoy started up its motors and moved off for the Pole of Inaccessibility. Just over one month later it reached the Sovietskaya station and after a halt of five days set off on the final lap of the expedition. Eighteen men led by E.T. Tolstikov made up the group. At the end of 11 days and 1,300 miles from the main base at Mirny, the convoy finally reached the point designated as the Pole of Relative Inaccessibility. Here a new continental observation post was set up. When scientific observation had been completed the convoy began the return journey to Mirny.

Until this venture ideas about the central area of eastern Antarctica were largely based on conjecture. Once an up-to-date scientific station had been set up in this region its former mystery disappeared. Instead of merely being able to pass on to the world's centres of science scraps of information picked up during reconnaissance trips, these new stations set up in the heart of the continent were now able to transmit detailed and extensive reports on all the geophysical processes taking place in the remotest corner of our planet.

A vast amount of scientific knowledge was also amassed by the convoys of tractor-drawn sledges used to set up the various stations. Observations were made throughout these expeditions and a thorough investigation was thus made of eastern Antarctica, the least accessible of all regions.

Aircraft played a major part in the setting up of the inland stations. They flew a total of 635,000 miles over the ice-cap and their observations made it possible to draw up a contour map of the surface of the east Antarctic ice-cap.

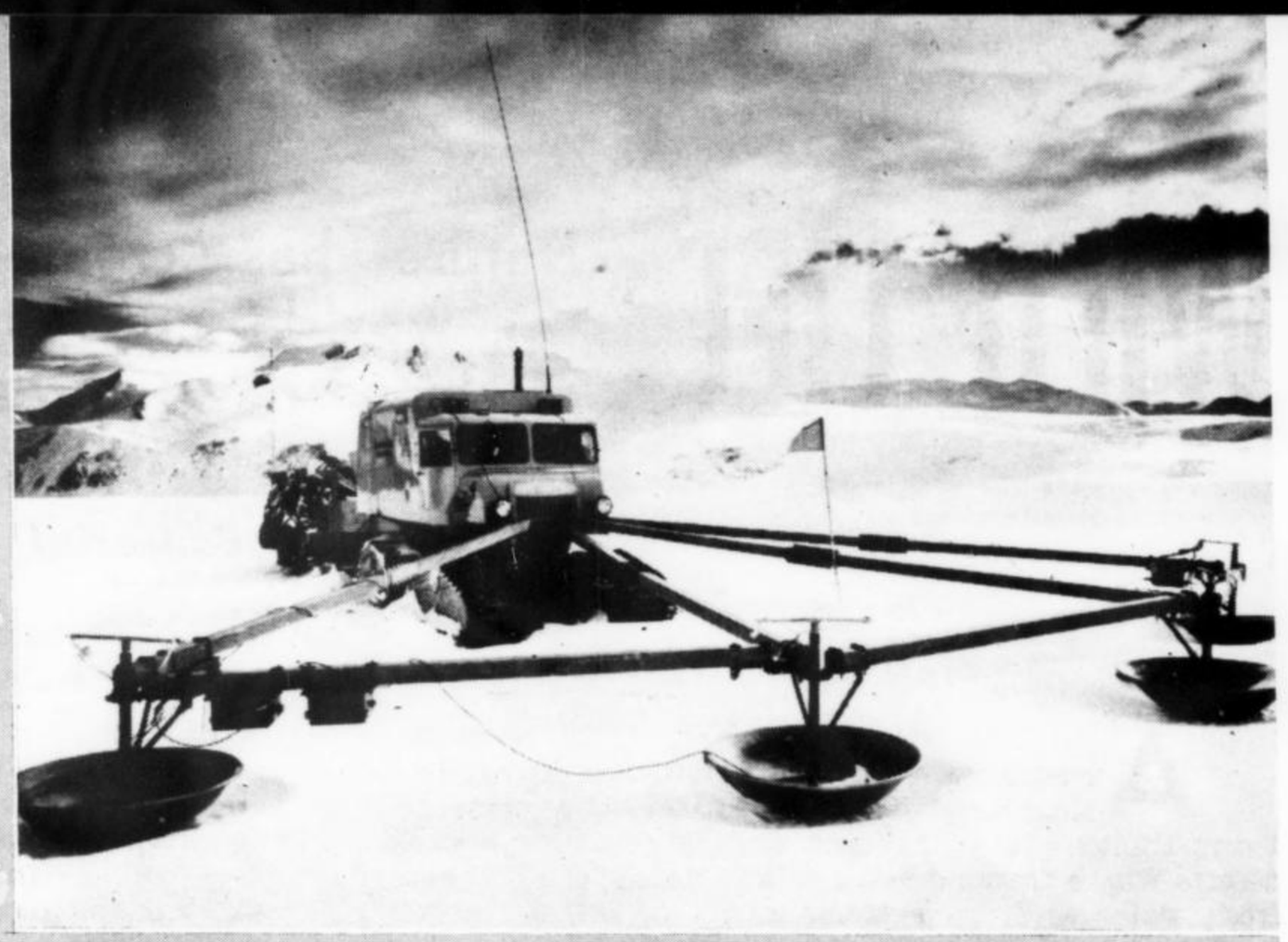
The existence of the sixth continent of our planet has only been known for the past one hundred and forty years. Its study has proceeded at a slow pace and its contours have only gradually been filled in on maps. Its secrets were only truly revealed during history's greatest science research project the International Geophysical Year.

Although the IGY has now ended officially, this remarkable example of scientific co-operation continues to develop through the international Antarctic Treaty which makes Antarctica the only continent of peace on our planet where not only war but every form of military activity is forbidden. As such, its importance to humanity grows greater every day for it shines as a brilliant example for all other continents.

M. M. SOMOV *has been active in polar research since* 1938. *He was head of the drifting ice-floe station North Pole-2* (1950-51) *and of the first Soviet Antarctic expedition* (1955-57). *Holder of the title, Hero of the Soviet Union, he was awarded in* 1959 *the Vega Gold Medal of the Swedish Anthropological and Geographical Society, and in* 1961, *the Patron's Gold Medal of the British Geographic Society. Dr. Somov is deputy director of the Arctic and Antarctic Research Institute of Leningrad and is also a permanent member of the Scientific Committee on Antarctic Research.*

THE THREAT OF HIDDEN CHASMS

© Trans-Antarctic Expedition



USIS

The vast white spaces look reassuringly smooth and safe. But the mantle of snow conceals deadly traps—enormous chasms large enough to swallow up entire convoys of tractors and sledges. During the Commonwealth Trans-Antarctic Expedition in 1958, a Sno-cat tracked vehicle in the party led by Vivian Fuchs broke through the lid of a deep chasm (left) and remained suspended across it like a bridge. To guard against such dangers, American explorer-technicians have devised a vehicle equipped with electronic detectors, (above) which reveal the presence of invisible crevasses. Below, the towering walls of a crevasse.

USIS

WILD LIFE

Nature has created unique species in the world's coldest climate. The arrival of man now threatens their existence.

by Rodolfo N. Panzarini

ANTARCTICA presents us with an environment singularly unsuited to the development of living things. It is in fact the largest of the world's deserts where freezing weather and winds, the absence of fresh water and the extreme rarity of soil surfaces all combine to make it impossible for plants to thrive. And it is on plants that all animals must depend for food, either directly or indirectly.

The picture is totally different when we turn to the Antarctic waters. Here we find conditions highly favourable for the growth of a marine flora of microscopic plant organisms which in spring and summer multiply by the millions and provide the basic nourishment for an abundant animal life.

The vegetable and animal kingdom of Antarctica is composed of a relatively small number of species but each is represented by an incredible number of individual creatures. They are a striking demonstration of how evolution has operated a high degree of specialization to adapt life to the harsh and very special conditions of a particular environment.

And since this environment provides very little food on land we find that no exclusively terrestrial animals exist anywhere in Antarctica. This explains too why birds and animals are to be found only on the shores and islands where nourishment in abundance is available from the sea; why so many animals emigrate from the region in autumn; why there are forms of life typically and exclusively Antarctic in nature; and why, finally, all plant and animal life is circumpolar in distribution.

On the mainland the chief botanical species are algae, mosses and lichens, but on the sub-Antarctic islands a sparse tundra has succeeded in establishing itself. Despite the sub-zero temperatures micro-organisms are known to exist in the atmosphere, and scientists have recently been successful in obtaining a proliferation of life from air samples cultivated in low-temperature laboratories. Various species have been isolated including several of the micro-fungi yeast variety.

THE Antarctic seas have been found to be teeming with an extraordinary multitude of microscopic unicellular algae of the diatom family. These form the greater part of the phytoplankton upon which birds and sea animals, including whales, regularly prey for food.

Land creatures are limited to the lower forms of life, a number of which are capable of subsisting in a state of suspended animation when conditions are particularly unfavourable. Birds and mammals are all of the marine variety except for the white-plumed Antarctic sheathbill which haunts the rookeries of penguins and is known for its predatory attacks on their eggs.

REAR-ADMIRAL RODOLFO PANZARINI *is director of the "Instituto Antarctico Argentino" and was in command of Argentina's Antarctic expeditions in* 1950-51 *and* 1952-53. *He was previously head of Argentina's Maritime Meteorological Service and is the author of "La Naturelza del Antarctico."*

The penguins are the best known of the sea birds of Antarctica, and their social habits are both curious and fascinating. Every spring they arrive on the islands and coast of the frozen continent and gather together in gigantic colonies. Here they breed and raise their chicks which must be strong enough by autumn to be able apparently to migrate to warmer latitudes further north.

The emperor penguin, the largest and stateliest of all the penguins, behaves in quite a different fashion. It makes its appearance in these latitudes not in spring but when the autumn is drawing to a close. No nest is built, and each couple produces only a single egg. The egg is incubated during the dark polar night by placing it on the feet of the male who shelters it under a fold of skin hanging apron-like from his abdomen.

In January the colonies of emperor penguins disperse and set themselves adrift on ice-floes moving out to sea. Where they spend their time until the following autumn remains a mystery.

Petrel, albatross, tern, gull, cormorant and skua, which all make penguin chicks their preferred prey also nest in Antarctica and remain there during the milder season.

OF the five species of seals only one—the sea elephant—is not a uniquely Antarctic creature. Among the others are the leopard seal, an implacable enemy of the penguin which it hunts voraciously and devours when they meet in the water. The fur seal belongs to another group which was almost completely exterminated by indiscriminate hunting about the middle of the last century. Now, after a hundred years, its population seems to be recovering.

Whales, our planet's largest animal, visit Antarctica in the spring to feed almost exclusively on the millions of tiny shrimplike crustaceans known as "krill." Over 80 per cent of the world's whale oil comes from Antarctic waters with the result that the whale is in perpetual danger of extermination.

The plants and animals of Antarctica, both those found on land and in the waters, form an integrated community with all its members closely dependent on each other for survival in this harsh climate which is a permanent challenge to them. All forms of life there play a role that is important from the standpoint of science, aesthetics and economics.

For the scientist Antarctic wildlife is of exceptional interest because the environment has given rise to forms of structural, physiological and ecological adaptation which are astonishingly specialized and refined, and which are to be found nowhere else in the world. And also because the same environment has led certain species to form colonies during the reproduction season and to disperse and seek refuge elsewhere during the remainder of the year. The former type of behaviour is usually associated with a highly developed social organization and the latter with migratory habits.

From the aesthetic viewpoint Antarctic animals possess not only great beauty but elegance and grace, and the charm that one attaches to things rare. Their very

© Jean Prévost

TEETH OF A KILLER. Holding open the jaws of a sea leopard, or leopard seal, this biologist member of a recent French polar expedition, displays the powerful fangs of the mortal enemy of the penguins. Named for the variegated colours of its fur, this Antarctic seal can grow to 12 feet in length. It is an especial foe of the small Adélie penguin; in the stomach of one leopard seal the remains of no fewer than 17 penguins were recently found.

presence brings life to the austere landscape, breaking its natural monotony and softening the feeling of dismay and oppression which the white wasteland makes on the human mind. Most of the animals show no signs of fear in the presence of man and allow him to approach to study their behaviour at close range. Though only of the most rudimentary type, the vegetation found in Antarctica also helps to break up the all-pervading whiteness.

The animals of Antarctica have an economic value too, since several species provide marketable products and in emergencies can be used by explorers for fuel and food. At present the economic value of its wildlife cannot compare with its scientific and aesthetic importance but this situation may well change before long.

The Antarctic is the last of the earth's continents to have been invaded by man and the only one still almost entirely in its natural state. But nature cannot escape the effects of man's arrival. By merely installing ourselves in the few places where vegetation can grow and animals congregate during the breeding season we threaten the flora, already extremly rare, and inevitably do damage to the fauna, the more so when we decimate their numbers for our own ends.

Such inroads can do irreparable harm and lead to the extinction of entire species of the utmost importance. In the past the damage caused by the massacre of animals hunted for their meat or skins has been disastrous even though limited to a few species.

Today's scientific invasion of Antarctica is obviously not aimed at hunting down the wild life of the region. Yet though inspired by totally different motives it constitutes a new but no less dangerous threat to the vegetable and animal kingdom of Antarctica.

Along with the great influx of men have come animals and other forms of life alien to the snow-covered continent, resulting sometimes in competition and even open hostility to the native fauna. The centuries-long isolation of Antarctica made it unnecessary for the species there to build up defence mechanisms to meet the challenge of outside encroachment. Ill-equipped to defend themselves they found themselves especially vulnerable to attack and their very survival was thus threatened .

Two examples of man's improvidence in Antarctica deserve special mention—the whale and the fur seal. The whale is being hunted in such numbers today that there are signs of its serious depletion. The seal, as already noted, has not been hunted on a commercial scale for the past century and is only now recovering from the ravages of the past.

Both need protection, the whale to avoid reaching the danger level of extinction, the seal until studies have shown that its population is stabilized and a safe maximum hunting quota has been determined.

Fortunately, when uncontrolled hunting eventually reduces catches to such an extent that commercial exploitation is abandoned, the recuperative power of the animals still appears to be strong enough to save them from total extinction. But it takes a long time before the species recover. Nevertheless it is both dangerous and uneconomical to approach this critical point. Dangerous, because any unforseen big catch may have

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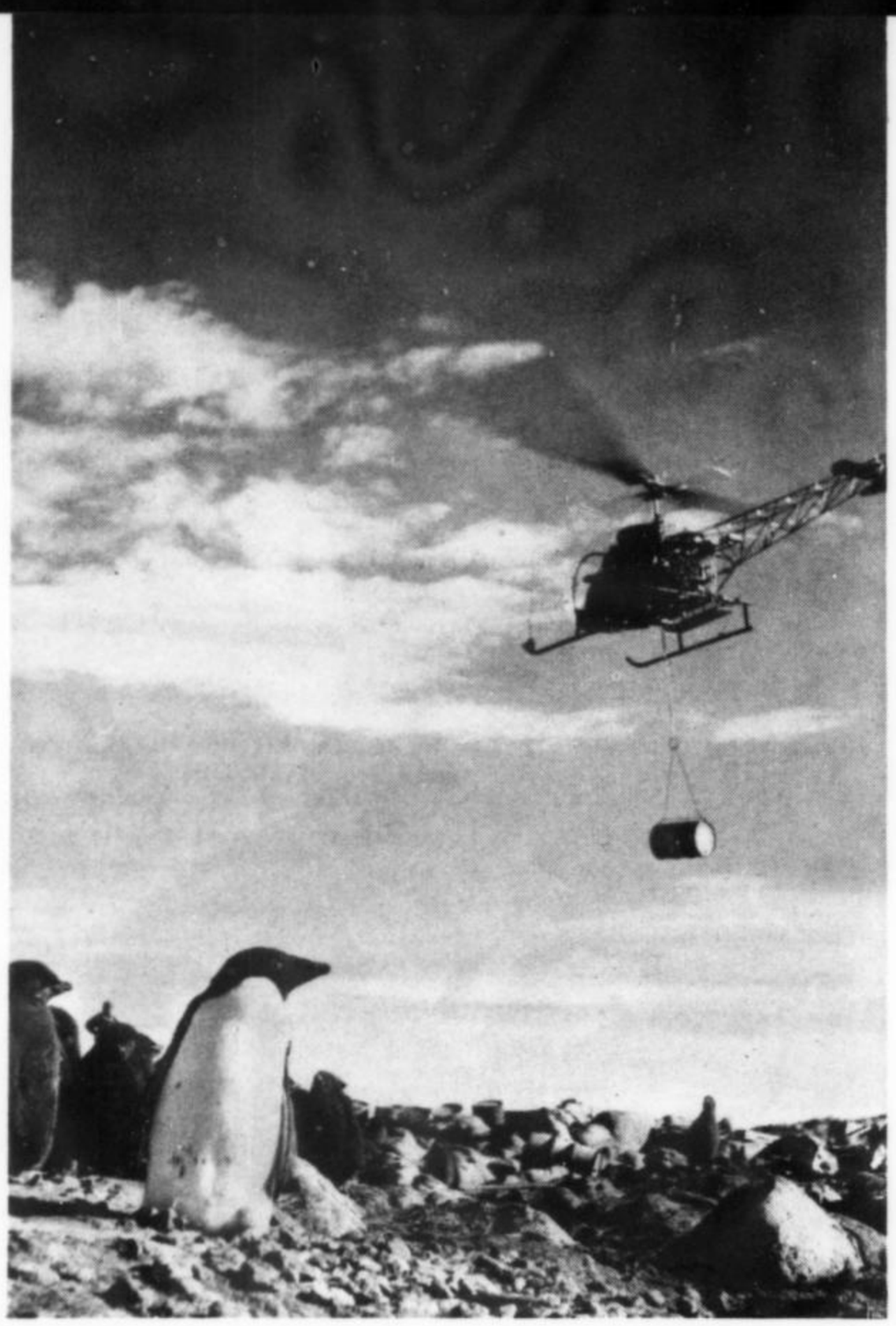

Photos Jacques Masson © Expéditions Polaires Françaises

LOW-FLYING HELICOPTER dumping supplies near Adélie penguins. This can often be a source of disturbance and danger to Antarctica's bird colonies especially during the breeding season. The small Adélie penguins are among the most comical and endearing of this family of Antarctic sea-birds. They bow, swagger, chatter and doze. They seal their courtship with a kiss (above) and watch carefully (below) over their downy chicks. Undoubtedly they look like ugly ducklings when compared with the handsome chicks of the emperor penguin opposite.

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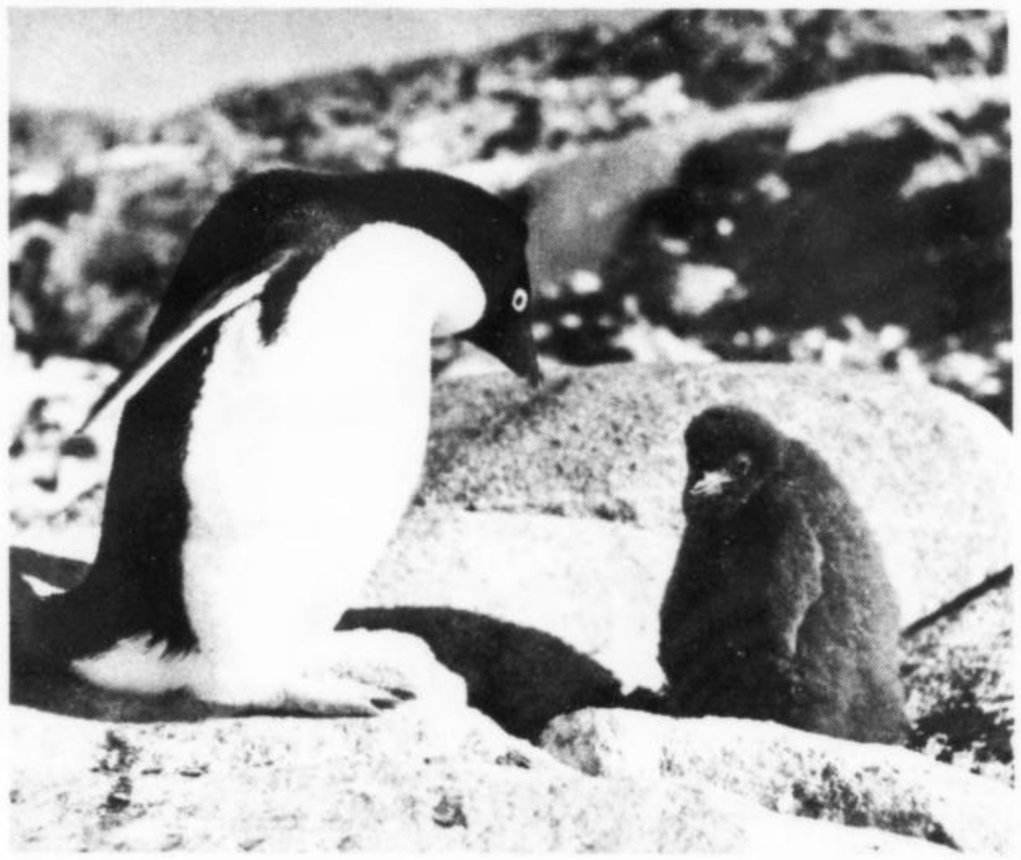

'PENGUINS' THAT FLY. Though true penguins are only found in the southern hemisphere in Antarctica, certain northern oceanic birds are also mistakenly referred to as penguins. These belong to the Alcidae or Auk family whose members nest in great colonies from Greenland, Iceland and Spitzbergen to North America and Northern Europe. Unlike Antarctic penguins these northern birds can fly (photo below) though one of their number, the great auk, became extinct because it could neither fly nor run. Two centuries ago millions of great auks still existed, but so many were killed off in a short-sighted hunt for their flesh and feathers that finally not one was left alive.

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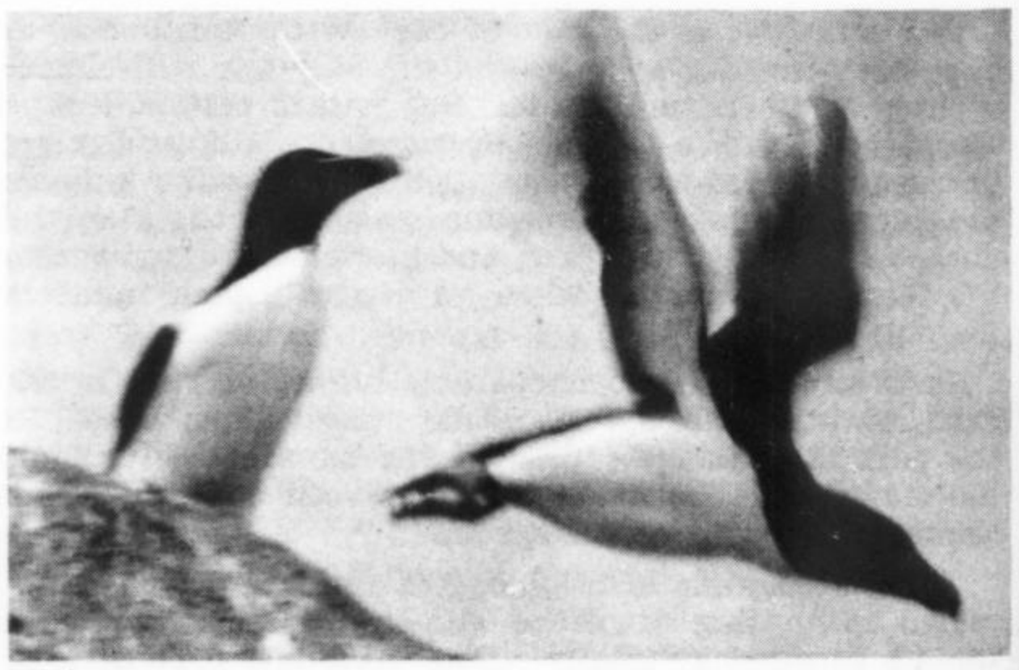

WILD LIFE *(Continued)*

Forbidden sanctuaries

catastrophic consequences on the survival of the depleted species; uneconomical because prolonged idleness in a commercial enterprise involving many men and machines obviously spells financial loss.

Although no one can deny man's right to turn to plants and animals to satisfy his needs we should remember that it would be unwise to do so in excess of what nature can provide. For example, the mass collection of eggs does not really affect the result of a breeding season since many of these eggs would never have reached the hatching stage anyway in the cold Antarctic climate. But the parent birds may be so disturbed as to abandon their usual mating grounds and seek another which it is very difficult to find outside of Antarctica.

If science is to progress, however, some measure of interference is inevitable and must be accepted, if only in the interests of nature preservation itself which depends on science and its findings to achieve positive results.

The problems of nature protection and preservation in Antarctica were first taken up in March 1959 at the third meeting of the Special Committee on Antarctic Research held in Canberra, Australia. A provision covering the subject was later included in the Antarctic Treaty signed in Washington the following December.

The preservation methods now recommended are based on general principles and on what little we know about the Antarctic biological world. It goes without saying that they will be revised in the light of new facts as they emerge from future scientific investigations.

But it is already abundantly clear that man's presence in Antarctica, which is increasing with every passing year, represents an increasing threat to the flora and fauna, and that protective measures are needed before it is too late.

The whole of Antarctica should now be recognized by all countries as a nature reserve, and even predatory species should receive protection so as not to disturb the natural

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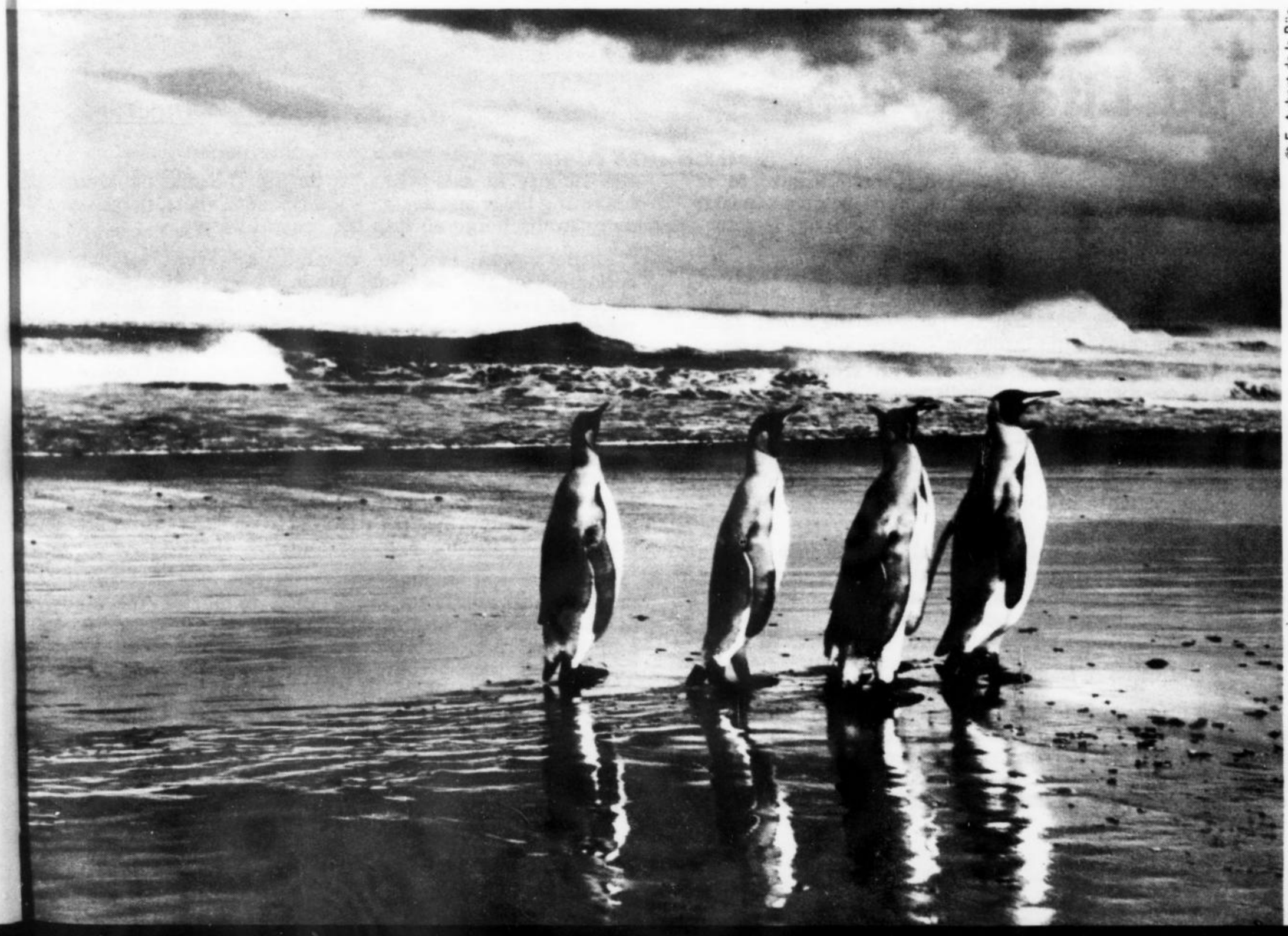
EMPERORS AND KINGS OF THE PENGUIN WORLD

Largest of Antarctica's flightless birds are the emperor penguins, above, seen warming chicks between their feet, and king penguins, below, out for a stroll along the seashore. Fossil bones of penguins found in the Antarctic show that some species must have been as tall as a man. Emperor penguins stand 3 1/2 feet high and weigh 90 pounds or more. They breed in the depth of winter, their single egg being hatched on the feet of the male (he maintains a fast, totalling 90 days before and during incubation). The emperors feed chiefly on fish or small octopuses (most other penguins eat shrimp) and usually live as monogamous couples.



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Sunspots and magnetic rings (Cont'd from page 30)

solar particles and its study near the southern auroral zone is very important. During intense magnetic storms the radio signals are absorbed and communication becomes impossible. During quiet periods near sunspot maximum, radio signals on higher frequencies than usual can be transmitted over very long distances and during 1958 European television sound signals were received in the Antarctic.

Ionospheric phenomena are easier to analyse at stations just outside the auroral zone but near to the geographic pole; one such station is that of the United Kingdom at Halley Bay. It was one of the very few Antarctic stations equipped for detailed IGY radio studies and many more like it will be required in the coming years to track the important horizontal and vertical movements of ionized gas observed there.

The weather of the southern hemisphere is controlled to a large extent by the ice covering of Antarctica—temperatures of -86° C were recorded at a Soviet station. Countries like Chile, Argentina, South Africa, Australia and New Zealand have always sought meteorological data from that region to improve their weather forecasts. Since the IGY many more stations are contributing data secured with radio-sonde balloons which transmit from heights up to 20 km (12 miles).

During the IGY weather data was sent several times a day, by radio, from each station to the Antarctic Weather Central at Little America. There United States meteorologists worked with colleagues from the U.S.S.R., Argentina, etc., to produce continental weather charts and forecasts.

Ozone gas, flowing at a height of about 25 km is a valuable indicator of air movements at high altitudes. The necessary delicate measurements have been done at some French and British Antarctic bases, and have shown that its annual variation differs from that in the Northern Hemisphere. Upper atmosphere sounding rockets fired from ships in Antarctic waters have also contributed to our knowledge of the upper atmosphere. We are beginning to understand the general circulation of the atmosphere up to great heights over the southern hemisphere but many more extensive and detailed measurements will be required before major advances in forecasting can take place.

This article has not touched on the rapidly expanding programme of biological research that has just begun, for these equally important activities are dealt with in a separate article by Rear Admiral Panzarini (See p. 36).

More observations of all kinds are required from the interior of Antarctica and in the coming years experimenters travelling by tractor or aircraft will improve the maps and gather data about Antarctic rocks and ice thickness. Modern techniques, such as meteorological satellites showing the area of ice as well as the amount of cloud cover and radio-isotope powered automatic weather stations (THE UNESCO COURIER, September 1957, page 20) sending regular radio reports, will gradually come into greater use. However, Antarctic research will never progress without the adventurous spirit which leads brave men to work in lonely huts, tending delicate apparatus in the face of many hazards.

Antarctic research became a major field of studies at the time of the IGY and the sunspot maximum; it will be further expanded in 1964-1965 at sunspot minimum with the International Year of the Quiet Sun (IQSY) programme and the peaceful conditions and free access permitted by the Antarctic Treaty will guarantee further expansion in the next few decades.

Wild Life (Cont'd from page 38)

biological equilibrium of the region. Areas deemed to be particularly important or vulnerable must be given special status as "sanctuaries" where human intrusion or interference of any kind would be strictly forbidden.

Special attention should be given to the protection of food sources from the sea. This could be done by prohibiting the exploitation of rich marine areas near points where birds and animals congregate.

Since nature recognizes only natural frontiers, international co-operation is indispensable if we wish conservation measures to be effective. These measures must also be the result of the international effort of all the countries now working together in the Antarctic in view of the circumpolar distribution of species, the isolation of the region and the precarious balance of the food cycle for all wild life.

Furthermore, no plant or animal species new to the region should be introduced before scientists have carefully examined all the possible consequences such action might entail. Domestic animals should be imported under strict control and limited to the minimum according to their chances of survival, their breeding capacity and usefulness to man.

Overall protective measures should be aimed particularly against actions likely to cause the most serious damage, i.e. allowing dogs to run loose, permitting helicopters, planes and motor vehicles to frighten or disturb bird colonies, setting off explosions or discharging firearms in the vicinity of seal rookeries during the mating season, molesting birds and seals by too frequent visits, permitting ships to discharge oil into the coastal waters.

Authorization can be granted, however, to obtain specimens of the flora and fauna of Antarctica provided that this is done under appropriate controls to ensure the conservation of the species. Thus the granting of permission would be considered quite legitimate for the completion or maintenance of zoological and botanical collections, for scientific collections or study, for enriching private collections of stuffed animals (for this purpose animals should never be killed but must have died a natural death). It is equally legitimate when required for the feeding of men and animals in Antarctica, and for commercial exploitation with the proviso that this be carried out in accordance with the established principles of nature preservation.

But it is not enough to define the elements of the problem and admit its importance, to pursue the study of the behaviour and characteristics of Antarctic plant and animal life, to lay down standards based on these findings and then prepare an international agreement for their application. What is needed, perhaps above all, is for each of us to feel personally responsible for the defence of a common interest. Without this the world at large may soon be deploring the loss of a beautiful and irreplaceable heritage which the wild life of Antarctica represents.

Letters to the Editor

MAKES WORLD SEEM SMALLER

Sir,

I would like to congratulate all concerned for the excellent way in which THE UNESCO COURIER is helping towards a genuine international understanding. Reading the magazine makes the world seem a much smaller place and makes me, and I am sure others also, feel responsible for situations elsewhere. I am very interested in the various philosophies and religions of the world and would welcome a greater coverage on these lines.

L. W. J. Pennington
Newcastle, N.S.W., Australia

A THIN HARVEST

Sir,

I was told your magazine was of general cultural interest, dealing with the sciences, painting, music, etc. Yet since I became a subscriber I have only been attracted by one article, dealing with fish—a rather thin harvest as I think you will agree. As I am neither Jewish nor Arab, neither a coloured person from another country nor a woman school teacher—your only satisfied readers, I am sure—I can assure you that I very much regret taking out a subscription for a magazine whose contents have so far left me entirely unsatisfied.

M. Petit
Paris, France

PROVOCATIVE BUT NOT SATISFYING

Having taken THE UNESCO COURIER for several years now, I would like to thank all concerned for providing me with so much information and entertainment. My only complaint is that the articles often lack depth. Whilst I can see that it may be your object to create an interest in a subject rather than to satisfy an existing curiosity, I often feel a sense of disappointment on reaching the end of an article, having been presented with only a brief survey of something that has intrigued me for some time. Still I appreciate that space is limited and yet a wealth of information is packed into a very inexpensive volume.

B. J. Burton
Manchester, England

THE FACTS ABOUT RACISM

Sir,

I am more than satisfied with my first year's subscription to your magazine. For a soldier, cut off from his usual sources of contact with the world, it is stimulating and a pleasure to read.

Naturally, I have not been interested to the same extent by all issues, but two in particular impressed me greatly: the one devoted to Velazquez and the one concerning Racism. This latter issue is one which should find its way into schools, universities and homes all over the world.

T. Vergely
French Army

PHOTOMICROGRAPHY OR MICROPHOTOGRAPHY?

Sir,

With all due respect to you and the dictionaries, D. K. Edwards of Victoria, British Columbia, is quite correct; it is now accepted English scientific and technical usage that a *photomicrograph* is a photograph taken through a microscope and a *microphotograph* a very small photograph. And, since scientists and technicians are the main users of photomicrographs that is an excellent reason for their usage to be generally accepted. Possibly an even better reason is that to do so gives different and precise meanings to two different words for two different things, to the consequent enrichment of the language. If, as you say, "in common usage the two terms are synonymous" then common usage is slipshod and should not receive your editorial encouragement. I believe that the Germans use "Mikrophotographie" for what we call photomicrography, which is perhaps a pity but does not alter my argument.

H. J. Walls
Newcastle-upon-Tyne, England

RELIGIOUS FANATICISM

Sir,

An issue devoted to the harm caused by religious fanaticism would provoke wide discussion among your readers for it is undeniable that different religions have always claimed for their own teachings the exclusive title of the true faith. There would be no need to go back to the days of the Inquisition. There are still people who hate others because of religious beliefs.

G. & A. Piou
Rezé-les-Nantes, France

ART IN THE LIFE OF MAN

Sir,

As an artist and instructor of art may I say Dr. d'Arcy Hayman's "Art in the Life of Man" should rank high among the works done to date to put men closer to the ordered way of cultural symphysis. Few authors have seen recorded so candidly the cultural pitfalls of our day, few have had the vision of the possibilities, truly wholesome and joyful, of lives well lived, of the total of the cultures fully grasped.

Truly this job will not be simple, nor does Dr. Hayman lead us to believe so, but if all men could see this common good in Art, then we have hopes and works worthy of ourselves and our children.

Let every man of good will, having this vision share it. First the artist through his work, second the users through their request.

R. F. McGovern
Philadelphia, U.S.A.

FASTEST GROWING CITY

Sir,

In the your June issue, Tibor Mende states in "Men of the Land" that in the capital city of one of the Latin American republics "about once every minute a new building was completed". According to this, 60 buildings an hour are completed here, which amounts to 1,440 buildings (60×24) in twenty-four hours. Consequently, in one year total construction in this capital equals no less than 450,000 buildings. We would like to know which republic in Latin America has a capital with such a highly developed building industry.

Syukhin, U.S.S.R.

Ed. note. Tibor Mende was referring to the city of Sao Paulo in Brazil which is considered the fastest growing city in the world. Building there does not, of course, go on 24 hours a day or on weekends. A more realistic estimate based on a 48-hours week gives a yearly total of approximately 150,000 buildings per year—still an amazing figure. Mr. Mende, however, said "...about once every minute."

MUSTS FOR LIBRARIES

Sir,

Writing on Books and Libraries in your May, 1961 issue André Maurois stated: "Our civilization is the sum of the knowledge and memories accumulated by the generations that have gone before us. We can only partake of it if we can make contact with ideas of those past generations. The only way to do this—and so become a "cultured person"—is by reading.

I agree with this wholeheartedly, but immediately wonder what books one should read. Quite apart from choices made on the basis of personal tastes, which are always controversial, there no doubt exist a series of "key" books of universal value. What are the 10, 25, 50 or 100 books which Unesco thinks should be on the shelves of every library?

Leopoldo Bustillo Sanchez
La Felguera, Spain

From the Unesco Newsroom

MORE MASS MEDIA FOR AFRICA

AFRICA has a lower level of literacy and is poorer in information facilities than any other region of the world. For every 100 people in this continent there are only, on the average, 1.2 copies of daily newspapers, 1.8 radio receivers and 0.5 cinema seats. Most of the African countries have no news agencies of their own and no television services.

Ways of providing Africa with the means of mass media it so badly needs, by aiding the development of newspapers, news agencies, radio broadcasting, films and television, will be considered at a Unesco-convened meeting in Casablanca, from January 24 to February 6.

The meeting, to which specialists from over 30 countries as well as observers from international organizations have been invited, is expected to recommend ways of expanding the rural press and promoting the use of radio and TV for news and information. Suggestions will also be made for improving film production and distribution and for training journalists in all the mass media. Special stress will be laid on the use of the media for education, a basic element in Africa's economic and social development. (Less than one year ago a Unesco Conference of African States in Addis Ababa drew up a five-year plan for extending primary education in the region).

The Casablanca meeting itself forms part of a world survey, which Unesco is making for the United Nations, on the problems of helping the less developed countries to build up their mass media. Two other regional meetings have been held—at Bangkok (for South-East Asia) and at Santiago (for Latin America)— and the final results of the survey will help the United Nations to evaluate the resources needed for a development programme.

SOVIET 'EYE' ON STORMS: The highest scientific station in the Soviet Union has been set up at a height of 13,780 feet in the Baubashata Mountains (Southern Kirghizia) to study atmospheric electricity. Swept by thunderstorms every five or six days, the Baubashata area is the centre of the greatest storm activity in Central Asia. From its mountain-top vantage point the station will make observations of the conditions of storm development, the parameters of lightning discharges, the Earth's electric field and ionisation of the air, in conjunction with the Uzbek and Tajik Academies of Sciences.

■ **AFRICA'S FLYING DOCTORS:** *Nigeria has recently created a Flying Doctor Service on the pattern of that which has saved countless lives in Australia's vast outback areas. Like the Australian service, Nigeria's will use the latest version of the two-way pedal radio. Power is generated by working a pair of pedals on a frame, but today's transceiver radios, powered by transistors, weigh only* 15 *pounds. Over* 1,000 *of them are now use in Australia.*

SHAKESPEARE IN NEW YORK: Free, open-air performances of Shakespeare's plays have recently been drawing large crowds of New Yorkers nightly to the Wollman Memorial Skating Rink Theatre in Central Park, New York City. The occasion has been the Sixth American Shakespeare Festival which is financed by contributions from over 5,000 donors—trade unions, business firms and foundations, students and other individual well-wishers—and by a subsidy from the New York City public funds.

■ **REPORT ON THE GALAPAGOS:** *Two* UNESCO*-sponsored expeditions to study the animal life of the Galapagos Islands of the coast of Ecuador (see* THE UNESCO COURIER, *Jan.* 1958, *Sept.* 1961) *have been led by Dr. J. Eibl-Eibesfeldt of the Max Planck Institute for Behaviour Physiology in Seeshaupt, near Munich. The findings of the expeditions have now been collected in a richly illustrated* 218*-page report entitled* Galapagos (*published by R. Piper & Co., of Munich*) *which gives completely new information about the unique fauna of the islands and suggests measures to protect it from extinction.*

LARGEST SCIENCE LIBRARY The world's largest scientific and technical library is now being built at the Siberian Division of the Academy of Sciences of the U.S.S.R. in Novosibirsk. The building is intended as a repository for ten million books. There will be sixteen reading rooms accommodating 3,000 readers.

■ **MENTAL HEALTH TODAY:** World Health, *the monthly magazine of the World Health Organization (WHO) reports that psychiatry and mental hygiene, instead of being among the least hopeful branches of therapeutic and preventative medicine, now belong to those which offer most promise. "Today", says the magazine, "we have perhaps reached a point where the mental disorders, which are among the most important mass diseases of the* 20*th century, can be attacked with the same expectation of success as were communicable diseases some decades ago. What is needed above all to further mental health is scientific research."*

UNESCO PHILATELIC SERVICE

Since its foundation in December 1946, the United Nations Children's Fund (UNICEF) has been helping many hundreds of millions of needy children and their mothers in all parts of the world through programmes covering maternal and child welfare services, disease control and child nutrition. Last month the work of UNICEF during the past 15 years was commemorated in the stamp shown above issued by the United Nations Postal Administration as the fifth in its 1961 series of commemorative stamps. In addition to the 4 cent (gold, blue, green and brown) denomination shown here, the UNICEF commemorative stamp was also issued in 3 cent (gold, orange, yellow and brown) and 13 cent (gold, purple, pink and green) versions. As the agent in France of the U.N. Postal Administration, Unesco's Philatelic Service stocks all the United Nations stamps currently on sale. It also has stamps and first day covers issued by many Unesco member states to commemorate important events in the history of Unesco and the U.N. (inauguration of Unesco's headquarters, Human Rights Day, World Refugee Year). Information on items available, their price and methods of payment will be sent on request by the Unesco Philatelic Service, place de Fontenoy, Paris-7e.

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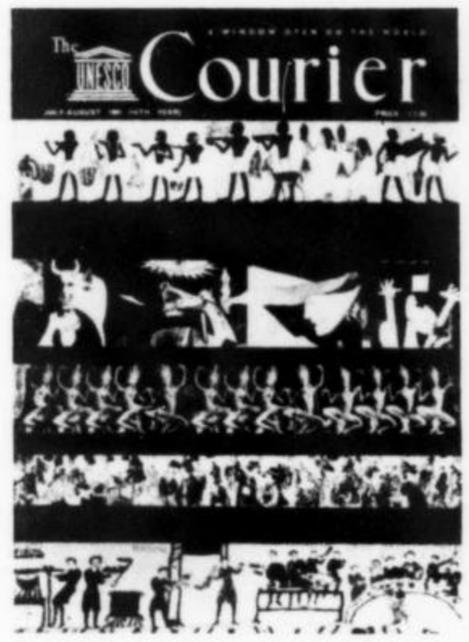

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SOCIAL SCIENCE TECHNICAL INFORMATION CENTER
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Jacques Masson © Expéditions polaires françaises.

WEATHER MEN IN THE 'ICE BOX'. The vast frozen mass of Antarctica—sometimes called the "Ice Box" of the globe—has a tremendous influence on world weather conditions and also with respect to glaciers and ocean currents. Today, scientists of many nations are working to probe the secrets of Antarctica and thus replace mysteries by sure, scientific information. France's scientists have been working in Adélie Land where, during the International Geophysical Year (1957-58), they established their Charcot Station 200 miles inland towards the magnetic pole. Charcot Station made research into magnetism and recorded weather information with meteorological observation equipment shown here.